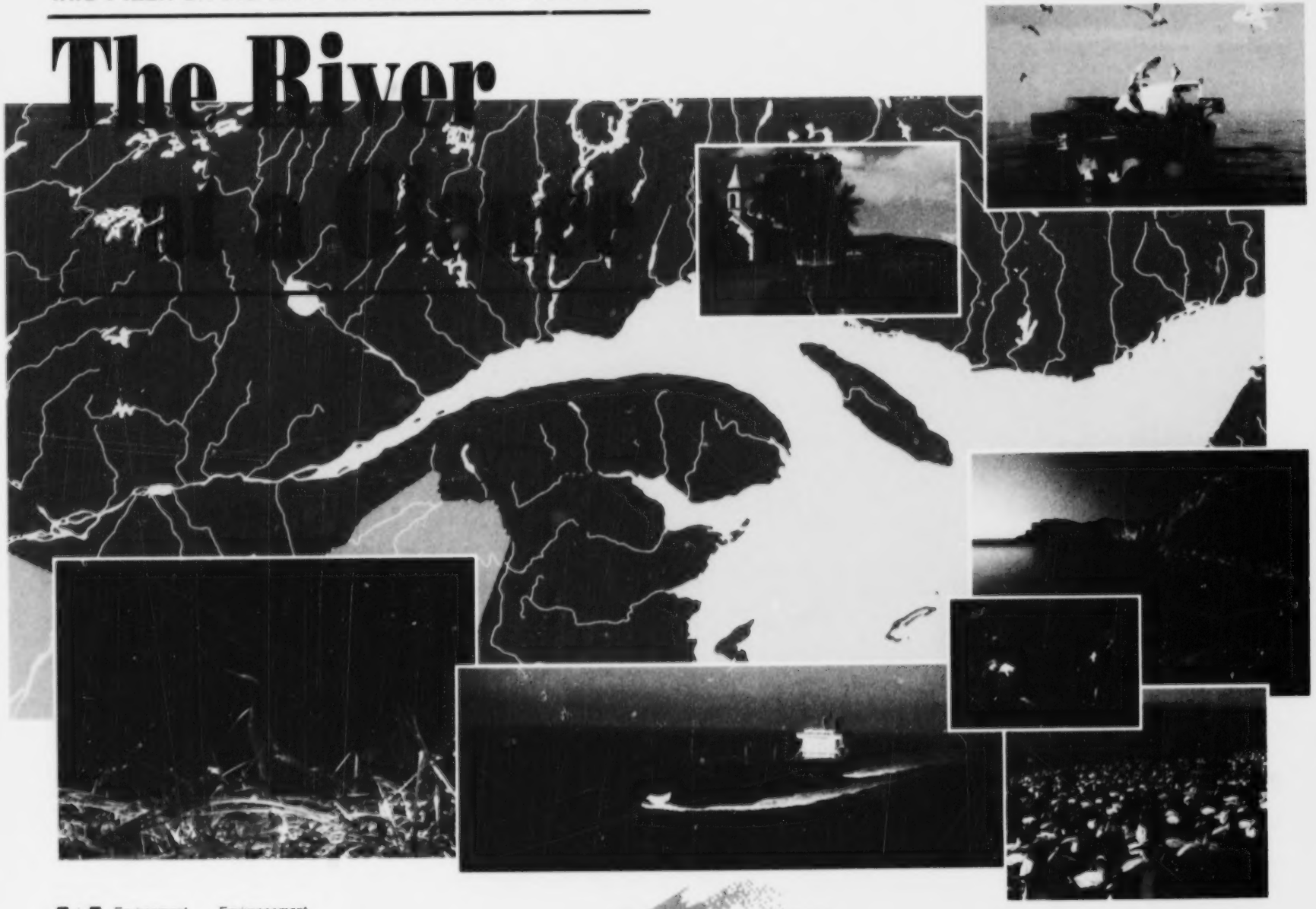
Info-Flash on the state of the St. Lawrence River

The River



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Saint-Laurent Vision 2000

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St. Lawrence UPDATE

Info-Flash fact sheets are part of a series of documents whose aim is to review the state of health of the St. Lawrence River. Prepared under the St. Lawrence Vision 2000 action plan, these fact sheets provide information on the biological, physico-chemical and socio-economic aspects of the River. They are designed and produced using the most up-to-date information available on a particular subject—a process that entails collecting, analysing, synthesizing and validating all kinds of data.

Info-Flash fact sheets are updated on a regular basis. They may be obtained by contacting:

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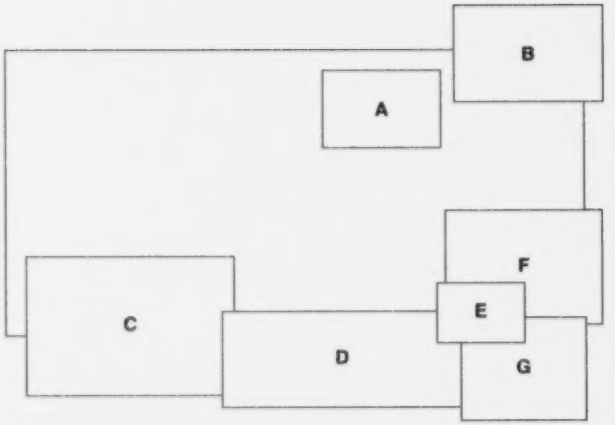

A Saint-Joseph-de-la-Rive. *Louise Quilliam.*

B Commercial fishery. *Pêche Impact.*

C American bittern. *Canadian Wildlife Service. Léo-Guy de Repentigny.*

D *Fisheries and Oceans Canada.*

E Common crab. *Parks Canada. Y. Boivin and C. Harvey.*

F Cap Bon Ami, Forillon Park. *Parks Canada. Jean Audet.*

G Northern gannet, Bonaventure Island. *Canadian Wildlife Service. Gilles Chapdelaine.*

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The River at a Glance: Evaluation Sheet

Saint-Laurent Vision 2000

103-03713/

Please take a few minutes to answer the following questions:

Circle your response

	Agree somewhat/Disagree		Agree		Agree strongly	
Themes selected offer a good overview of the St. Lawrence River	1	2	3	4	5	6
Text is clear	1	2	3	4	5	6
Maps and graphics are easy to understand	1	2	3	4	5	6
Vocabulary is not overly technical	1	2	3	4	5	6
Text and visual elements are well-balanced	1	2	3	4	5	6

How will you use the information in these fact sheets?

- For my personal interest _____
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Have you ever consulted the Info-Flash fact sheets on Environment Canada's Internet site (http://www.qc.doe.ca/envcan/index.html)?

Yes _____ No _____

Comments _____

_____

_____

To which group do you belong?

☐ Educator ☐ Industry ☐ Federal government ☐ Municipalities ☐ Association: _____

☐ General public ☐ Media ☐ Provincial government ☐ Other: _____

Please complete and return this form, addressed to the attention of Ms. Linda Plante, by fax (514) 283-9451, or by mail to Environment Canada, St. Lawrence Centre, 105 McGill Street, 7th Floor, Montreal, Quebec, H2Y 2E7

Stéphane Lorrain

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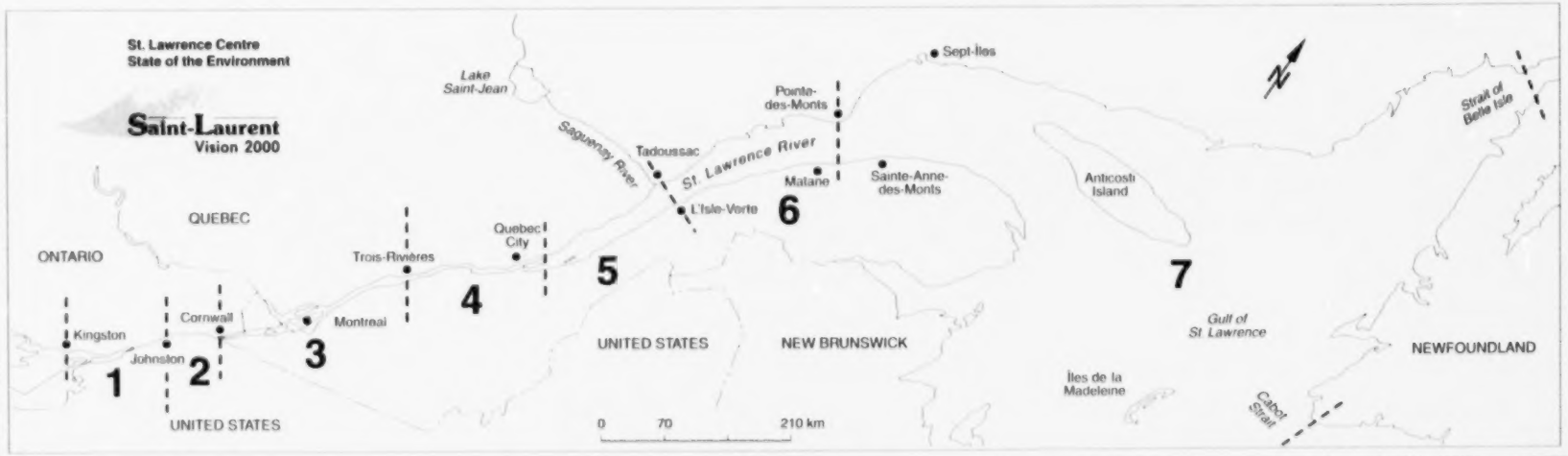
INFO-FLASH 1

Up and Down the St. Lawrence River

Section	From... To...	Length (km) by section	Length (km) Total	Width (km)	Altitude (m)	Depth (m)	Section	Main tributaries: North shore	Main tributaries: South shore
1. THOUSAND ISLANDS	Kingston	114	184	2	74		Freshwater: No tides		
2. INTERNATIONAL RAPIDS	Johnston Bridge	70							
	Cornwall			5 (Lake Saint-François)	46				
QUEBEC BORDER									
3. FLUVIAL SECTION	Montreal	400			7	10 to 12		Du Nord Ottawa L'Assomption Saint-Maurice	Richelieu Yamaska Saint-François
	Trois-Rivières			2				Jacques-Cartier	
4. FLUVIAL ESTUARY	Quebec City			1 (and 870 m at Quebec City bridges)			Weak tides		Chaudière Etchemin
	Cap Tourmente Île d'Orléans (eastern tip)			15					
5. UPPER ESTUARY			1400 to 1600			100	Brackish		Ouelle
	Tadoussac L'Isle-Verte					to		Saguenay	Du Loup
6. LOWER ESTUARY	Baie-Comeau			60		300	Saltwater: Strong tides (4 to 6 m)	Betsiamites Aux Outardes Manicouagan	
	Pointe-des-Monts between Matane and Sainte-Anne-des-Monts							Moisie	
7. GULF	Sept-Îles			100		400*		Magpie Romaine Natashquan Du Petit Mécatina	Cascapédia Matapédia
	Strait of Belle Isle	1200							
	Cabot Strait	1000							

●●●● Dividing line between fresh/brackish/salt water

Source:
- Government of Canada. 1991. *The State of Canada's Environment.*
- Lasserre, J.-C. 1980. *Le Saint-Laurent, grande porte de l'Amérique.* Hurtubise HMH.
- Ministère de l'Environnement du Québec. 1988. *L'environnement au Québec, un premier bilan.*



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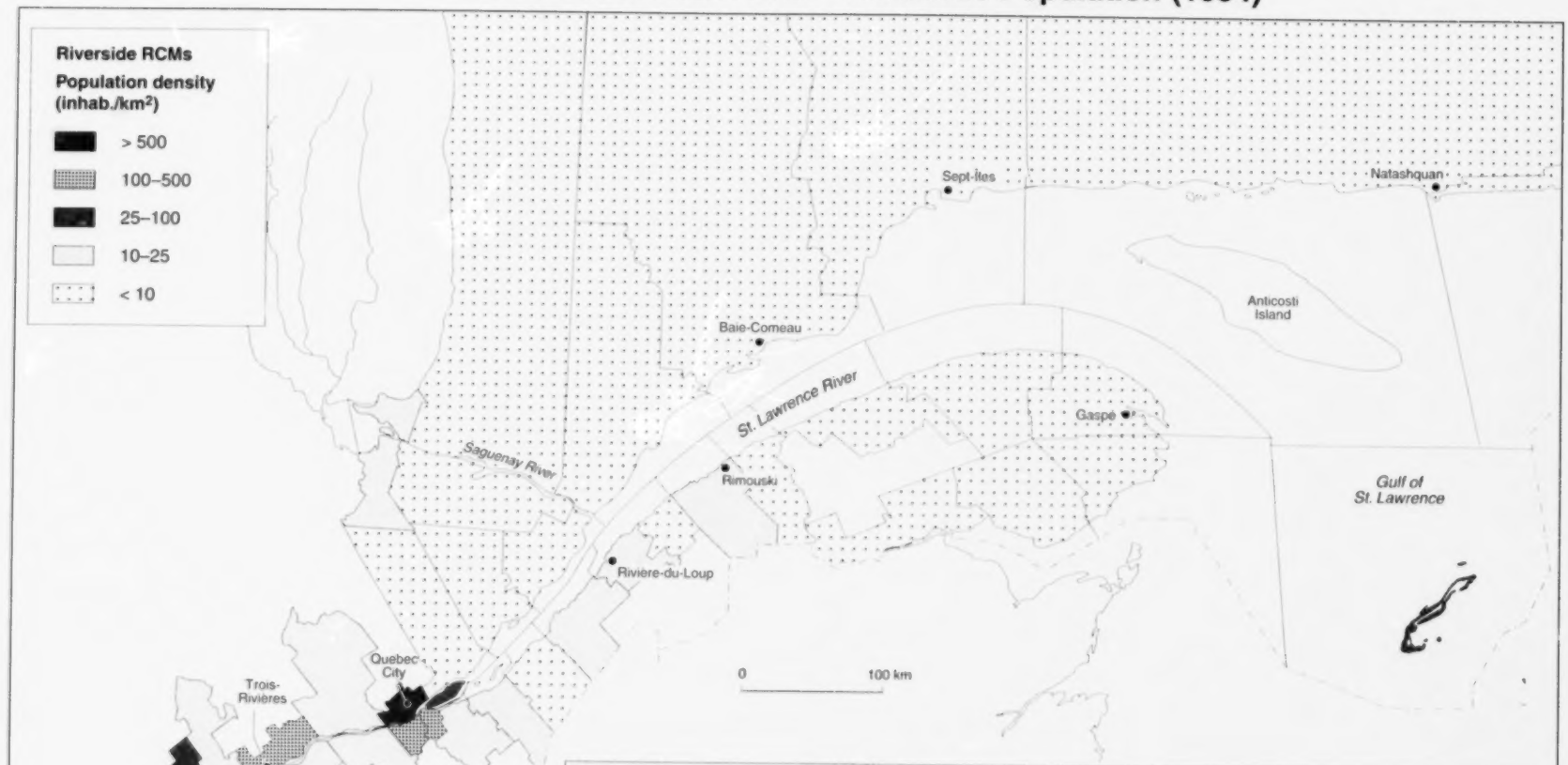
INFO-FLASH 2

The St. Lawrence River – Riverside Population (1994)



	Population (inhabitants)	Area (km²)	Density (inhab./km²)	Number of riverside RCMs
North shore	1 461 127	281 160.72	5.20	20
South shore	1 233 233	46 577.12	26.48	26
MUC	1 799 254	503.76	3 571.65	-
QUC	511 805	544.75	939.52	-
Others*	5 015	6 156.64	0.81	-
Total	5 010 434	334 942.99	14.96	46
Quebec	7 207 992	1 523 221.18	4.73	96

* Five north shore municipalities do not belong to an RCM.

The population of riverside regional county municipalities (RCMs) makes up 70% of the total population of Quebec and occupies 22% of the land.

Source: • Map of RCMs from the Ministère des Affaires Municipales du Québec. 1983.
• Ministère des Affaires Municipales. 1995. *Répertoire des municipalités du Québec – 1995*. Les Publications du Québec.

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The St. Lawrence River – Riverside Native Communities

Name	Nation	Location (census division)	Population in 1995			Area of territory* (km²)
			On reserve	Off reserve	Crown land	
NORTH SHORE						
Kanesatake	Mohawk	Deux-Montagnes	1 258	571	0	9.70/S
Wendake (Huron village)	Huron-Wendat	Quebec City	1 092	1 610	2	0.70/R
Essipit (Les Escoumins)	Montagnais	Saguenay	187	182	0	0.39/R
Betsiamites	Montagnais	Saguenay	2 462	420	1	255.37/R
Uashat-Maliotenam	Montagnais	Saguenay	2 319	543	0	6.08/R
Mingan	Montagnais	Saguenay	415	13	0	19.15/R
Natashquan	Montagnais	Saguenay	675	44	2	0.21/R
La Romaine	Montagnais	Saguenay	839	8	8	0.14/R
Pakuashipi	Montagnais	Saguenay	4	0	218	0.04/S
SOUTH SHORE						
Akwesasne**	Mohawk	Huntingdon	3 332	149	0	11.49/R
Kahnawake	Mohawk	La Prairie	6 693	1 554	0	41.52/R
Odanak	Abenaki	Yamaska	298	1 278	0	6.07/R
Wôlinak	Abenaki	Nicolet	115	199	0	0.7/R
Viger (Cacouna)	Malecite	Rivière-du-Loup	1	499	0	0.00/R
Gesgapegiag	Mi'kmaq	Bonaventure	463	527	0	1.82/R
Listuguj (Restigouche)	Mi'kmaq	Bonaventure	1 996	753	0	36.42/R
Gaspé	Mi'kmaq	Gaspé	0	439	0	0.00/NT
TOTAL			22 149	8 789	231	389.80

Note: Native communities were formerly called "Indian bands". They are regulated by the *Indian Act*. The name of each community is chosen by resolution of the band council.

* Calculated using a planimeter on cadastral maps of the provincial Ministry of Natural Resources and topographical maps of Energy, Mines and Resources Canada.

R: Reserve – An expanse of land defined by federal law and set aside for the use and benefit of the community.
S: Settlement – Territory identified but without reserve status and inhabited by a community.
NT: No territory.

** Quebec portion only.

( ) Common appellation.

Source: Indian and Northern Affairs Canada. 1996. *Population du registre des Indiens selon le sexe et la résidence 1995.*

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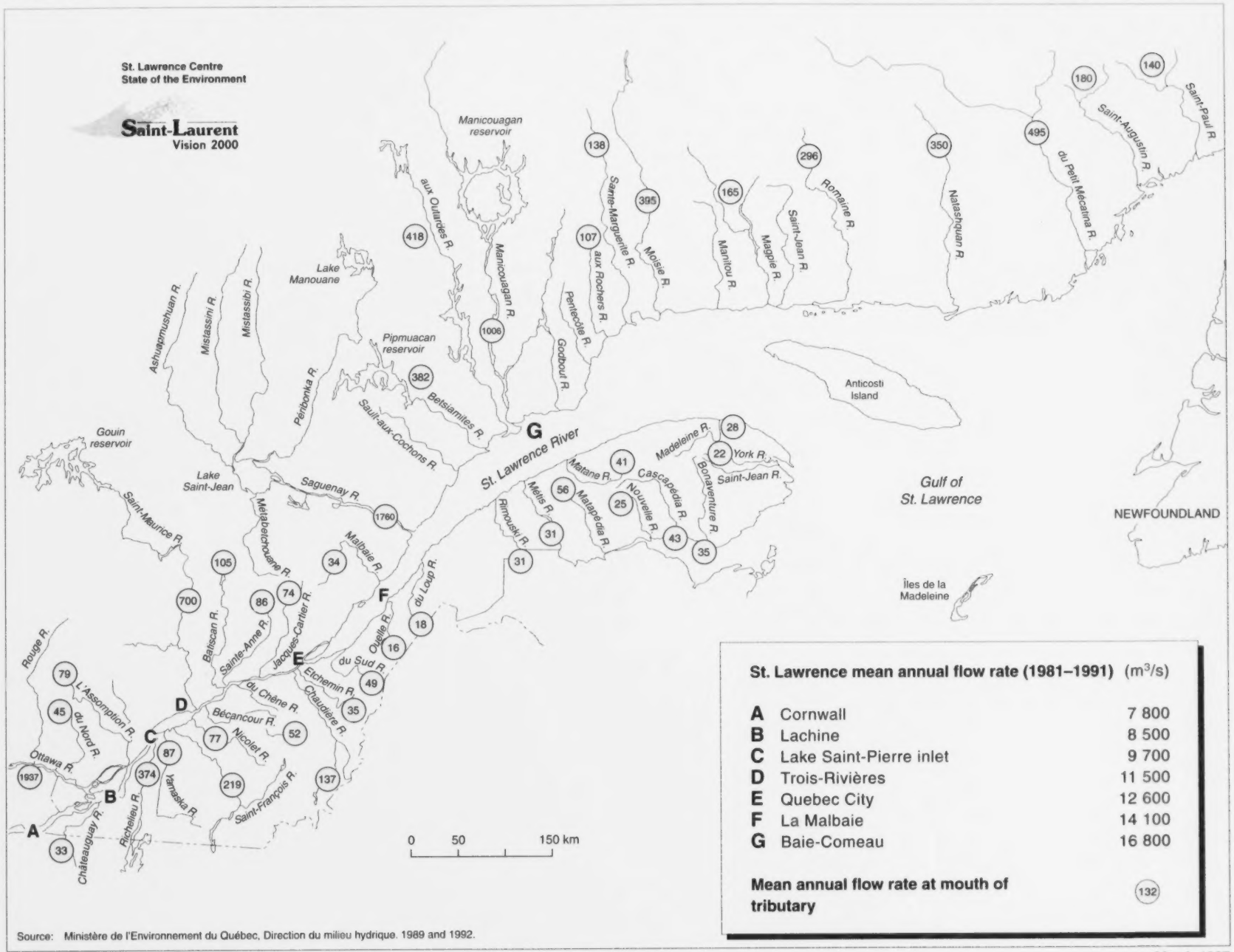
The St. Lawrence River and its Main Tributaries – Mean Annual Flow Rate



St. Lawrence mean annual flow rate (1981–1991) (m^3/s)

A	Cornwall	7 800
B	Lachine	8 500
C	Lake Saint-Pierre inlet	9 700
D	Trois-Rivières	11 500
E	Quebec City	12 600
F	La Malbaie	14 100
G	Baie-Comeau	16 800

Mean annual flow rate at mouth of tributary (132)

Source: Ministère de l'Environnement du Québec, Direction du milieu hydrique. 1989 and 1992.

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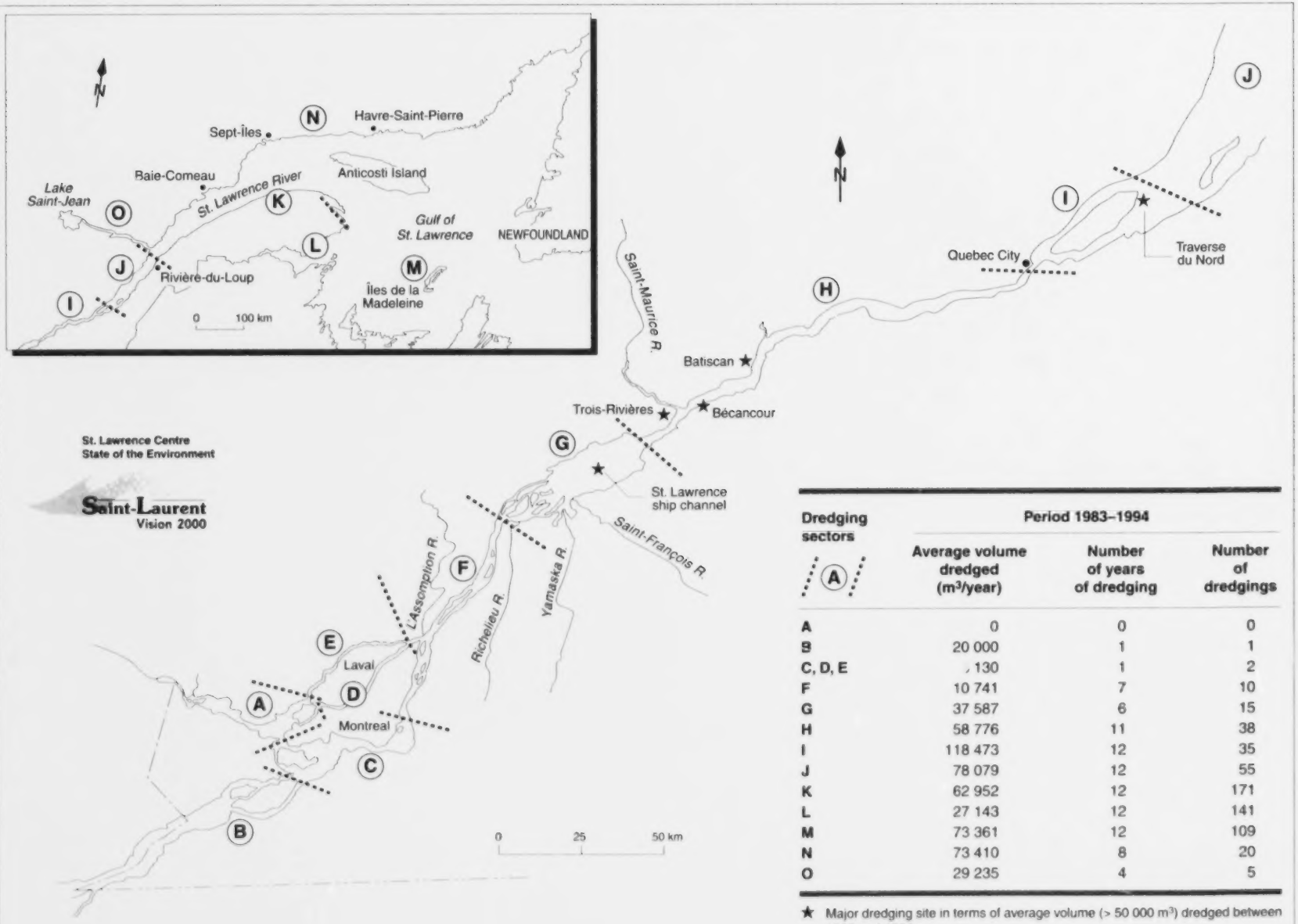
The St. Lawrence River – Average Annual Volume of Sediment Dredged (1983–1994)



Dredging sectors	Period 1983–1994		
	Average volume dredged (m^3/year)	Number of years of dredging	Number of dredgings
A	0	0	0
B	20 000	1	1
C, D, E	, 130	1	2
F	10 741	7	10
G	37 587	6	15
H	58 776	11	38
I	118 473	12	35
J	78 079	12	55
K	62 952	12	171
L	27 143	12	141
M	73 361	12	109
N	73 410	8	20
O	29 235	4	5

★ Major dredging site in terms of average volume (> 50 000 m^3) dredged between 1983 and 1994.

The dredging necessary for maintenance of the St. Lawrence Seaway and access channels and in the construction and maintenance of port facilities was considered in calculating dredged volumes.

Source: Environment Canada. 1995. *Banque de données sur les dragages et la qualité des sédiments*. Environmental Protection Branch, Technology Development Section.

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INFO-FLASH 6

The St. Lawrence River – Municipalities with Drinking Water Intakes (1995)

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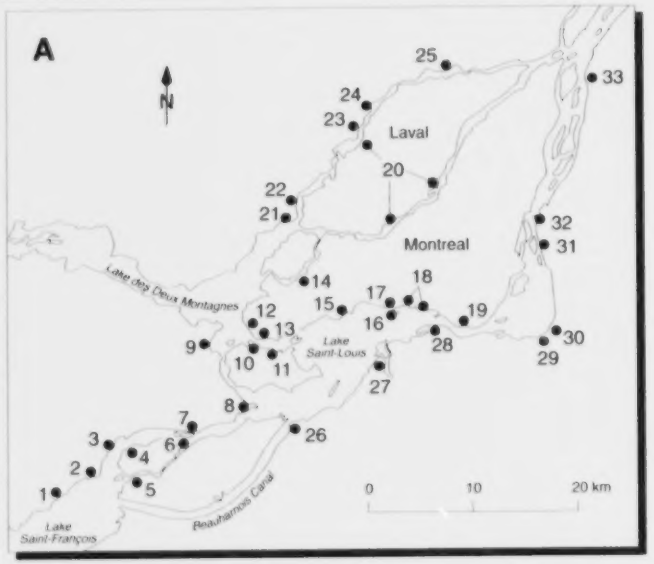

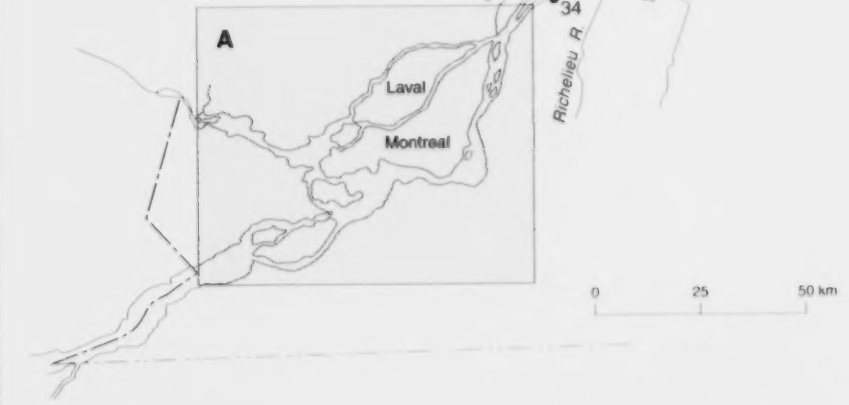

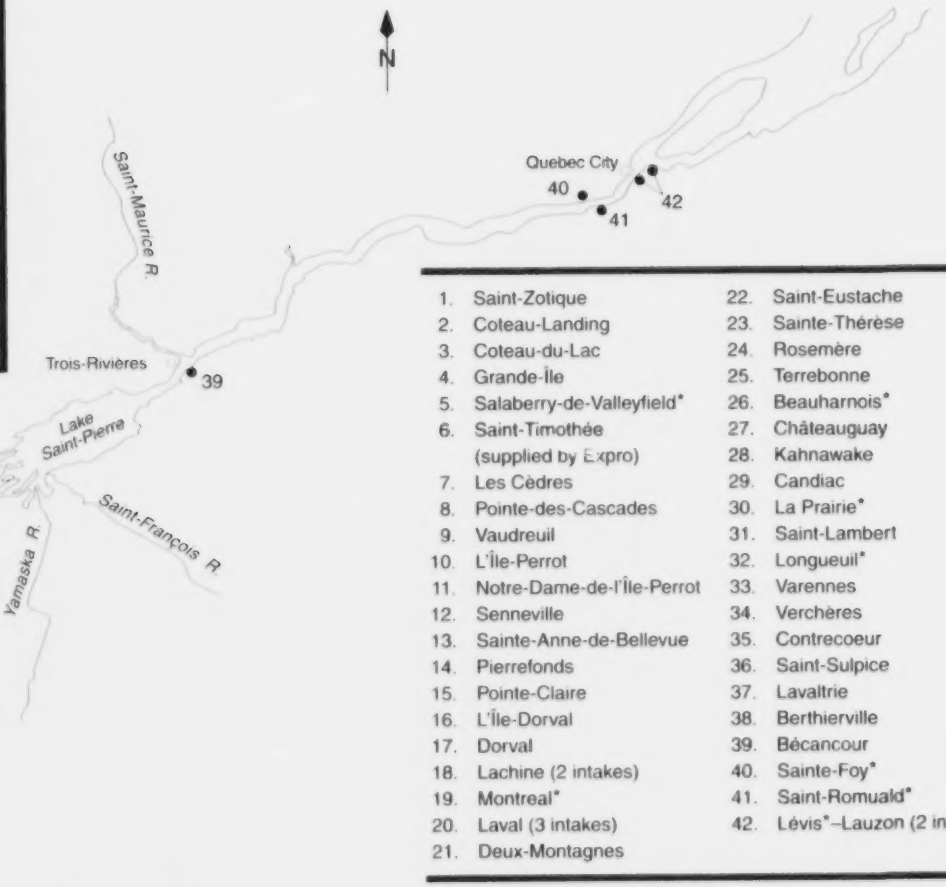

1. Saint-Zotique
2. Coteau-Landing
3. Coteau-du-Lac
4. Grande-Île
5. Salaberry-de-Valleyfield*
6. Saint-Timothée (supplied by Expro)
7. Les Cèdres
8. Pointe-des-Cascades
9. Vaudreuil
10. L'Île-Perrot
11. Notre-Dame-de-l'Île-Perrot
12. Senneville
13. Sainte-Anne-de-Bellevue
14. Pierrefonds
15. Pointe-Claire
16. L'Île-Dorval
17. Dorval
18. Lachine (2 intakes)
19. Montreal*
20. Laval (3 intakes)
21. Deux-Montagnes
22. Saint-Eustache
23. Sainte-Thérèse
24. Rosemère
25. Terrebonne
26. Beauharnois*
27. Châteauguay
28. Kahnawake
29. Candiac
30. La Prairie*
31. Saint-Lambert
32. Longueuil*
33. Varennes
34. Verchères
35. Contrecoeur
36. Saint-Sulpice
37. Lavaltrie
38. Berthierville
39. Bécancour
40. Sainte-Foy*
41. Saint-Romuald*
42. Lévis*–Lauzon (2 intakes)

* Municipalities whose sole source of drinking water is the St. Lawrence River (1988).

42 riverside municipalities have water intakes which serve, in whole or in part, 100 municipalities, or 45% of the population of Quebec (about 3 million people).

More than 2 billion litres of water are drawn from the St. Lawrence every day.

Source: Ministère de l'Environnement du Québec. 1989. *Banque de données (MUNFLEUV.DBF)*. Direction des écosystèmes urbains, Direction Réseau hydrique et directions régionales.

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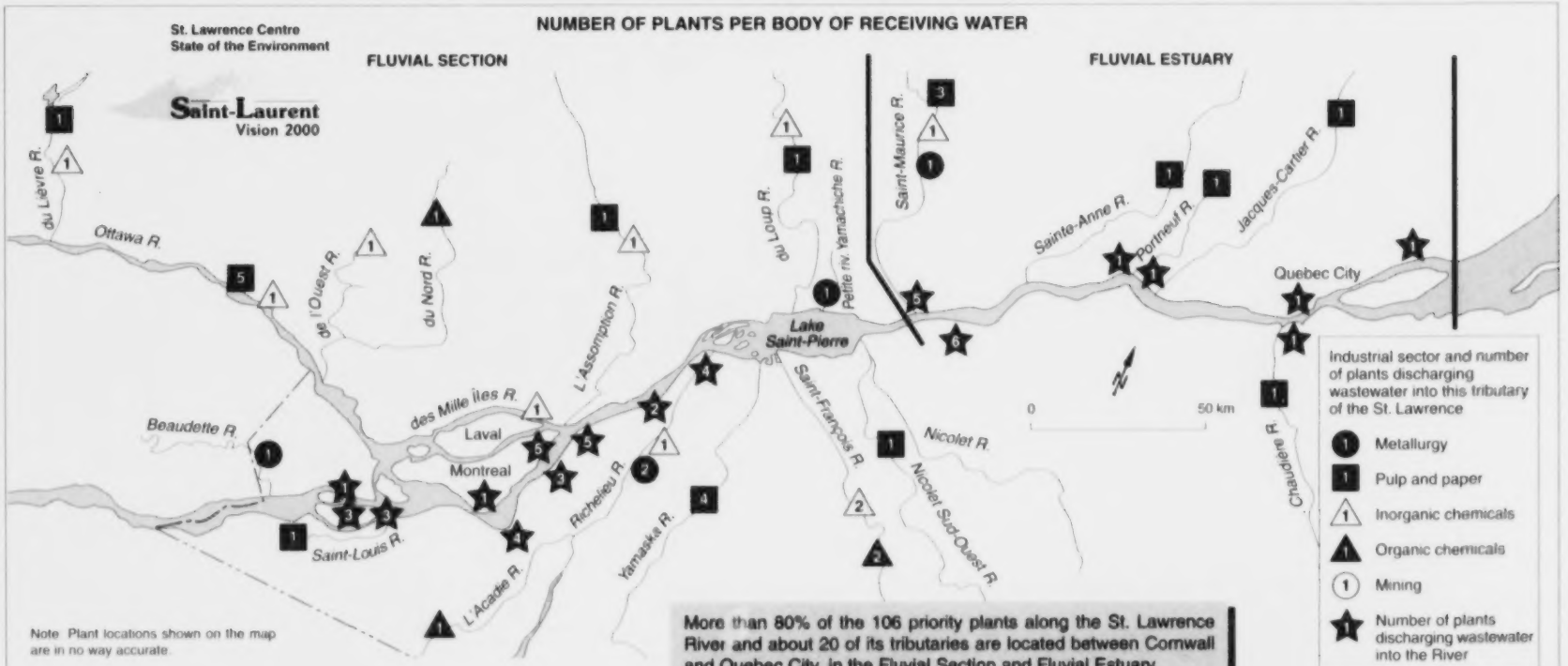
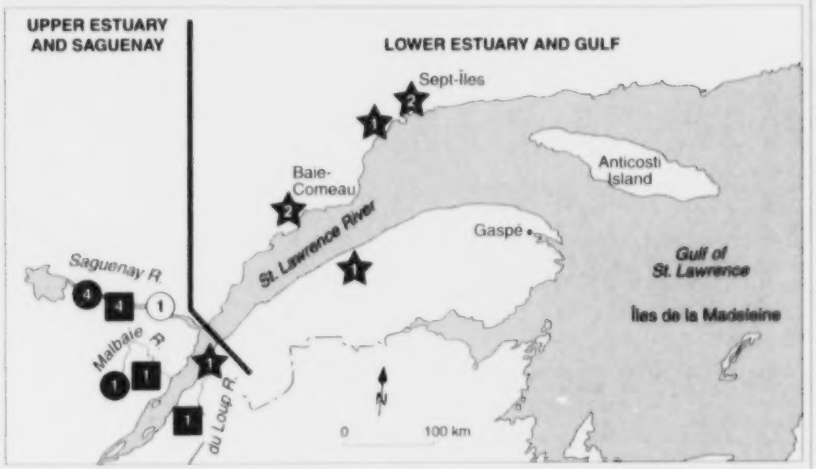
The St. Lawrence River – The 106 Priority Plants of St. Lawrence Vision 2000



NUMBER OF PRIORITY PLANTS PER INDUSTRIAL SECTOR AND RIVER SECTION

	Receiving water									
	Fluvial Section		Fluvial Estuary		Upper Estuary and Saguenay		Lower Estuary and Gulf		Total	
Industrial sector	***SL***	***TRIB***	***SL***	***TRIB***	***SL***	***TRIB***	***SL***	***TRIB***	***SL***	***TRIB***
Metallurgy	9	4	6	1	0	5	2	0	17	10
Pulp and paper	1	14	7	7	1	6	2	0	11	27
Inorganic chemicals	10	9	1	1	0	0	0	0	11	10
Organic chemicals	11	4	2	0	0	0	0	0	13	4
Mining	0	0	0	0	0	1	2	0	2	1
Total	31	31	16	9	1	12	6	0	54	52

SL Plants releasing wastewater into the St. Lawrence.
TRIB Plants releasing wastewater into one of the 24 tributaries mapped here. In the case of the Saguenay River, the discharges may refer to those made to one of its tributaries.



Source: Bouchard, I. 1995. *Base de données interne sur les 106 usines prioritaires de Saint-Laurent Vision 2000*. St. Lawrence Action Team.

Environment Canada Environnement Canada

Canada

March 1997

INFO-FLASH 8a

The St. Lawrence River – Protected Areas of Natural Shoreline: Montreal–Rimouski

Symbol	Protective Status	Agency Responsible	Number	Area (km²)
Federal jurisdiction (1274.2 km²)				
▲	Marine park*	Canadian Heritage (Parks Canada) Ministère de l'Environnement et de la Faune	1	1138.00
●	National wildlife area	Environment Canada (Canadian Wildlife Service)	6	52.30
◉	Migratory bird sanctuary		19	83.90
○	Migratory bird no-hunting zone		12	NA
Provincial jurisdiction (446.25 km²)				
■	Provincial conservation park	Ministère de l'Environnement et de la Faune	3	409.00
▣	Provincial recreation park and regional park		3	32.30
★	Ecological reserve		5	2.26
★	Wildlife preserve		2	3.70
		TOTAL		1732.71

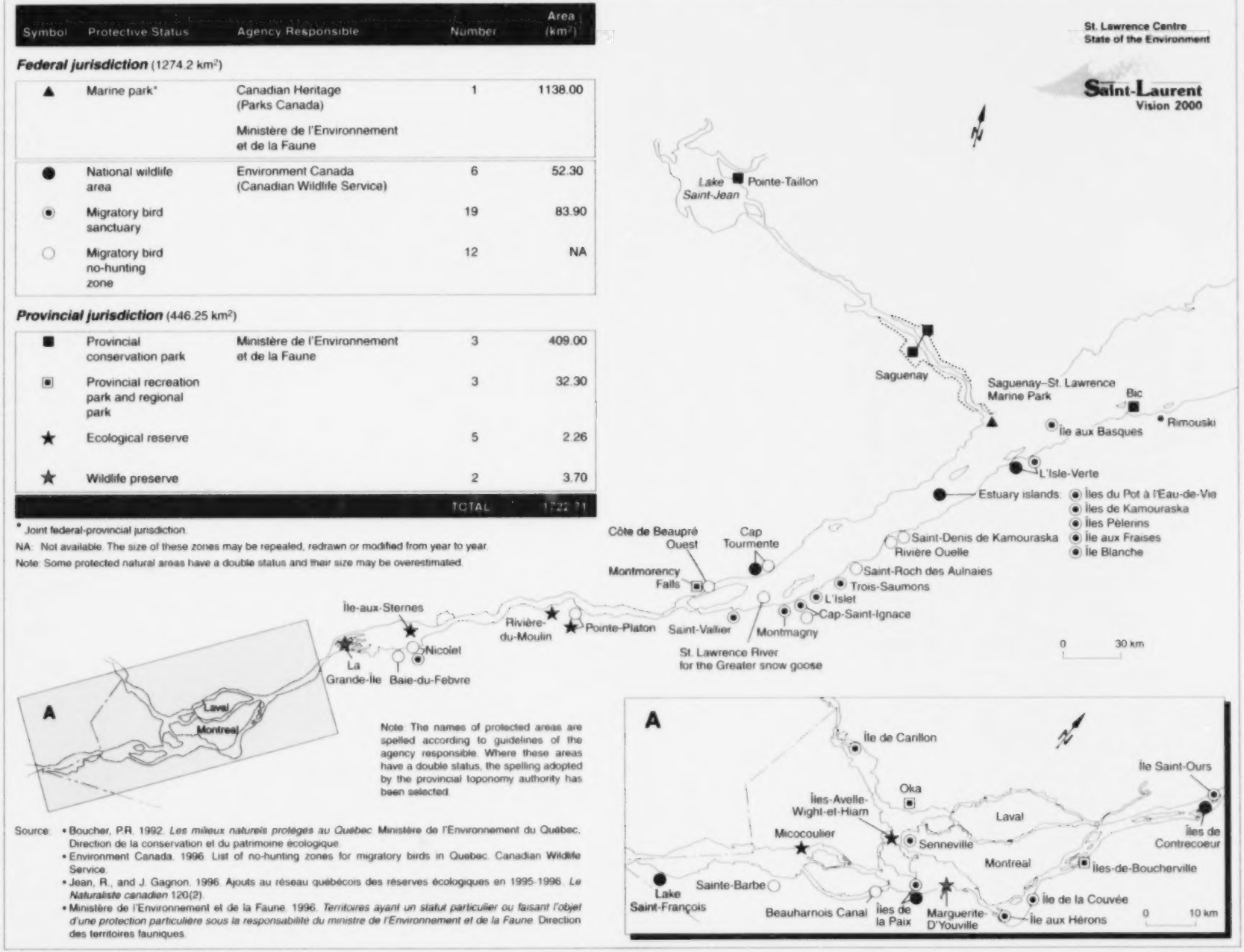
* Joint federal-provincial jurisdiction.

NA: Not available. The size of these zones may be repealed, redrawn or modified from year to year.

Note: Some protected natural areas have a double status and their size may be overestimated.

Note: The names of protected areas are spelled according to guidelines of the agency responsible. Where these areas have a double status, the spelling adopted by the provincial toponomy authority has been selected.

Source:
- Boucher, P.R. 1992. *Les milieux naturels protégés au Québec*. Ministère de l'Environnement du Québec, Direction de la conservation et du patrimoine écologique.
- Environment Canada. 1996. List of no-hunting zones for migratory birds in Quebec. Canadian Wildlife Service.
- Jean, R., and J. Gagnon. 1996. Ajouts au réseau québécois des réserves écologiques en 1995-1996. *Le Naturaliste canadien* 120(2).
- Ministère de l'Environnement et de la Faune. 1996. *Territoires ayant un statut particulier ou faisant l'objet d'une protection particulière sous la responsabilité du ministre de l'Environnement et de la Faune*. Direction des territoires fauniques.



Environment Canada / Environnement Canada

Canada

March 1997

INFO-FLASH 8b

The St. Lawrence River – Protected Areas of Natural Shoreline: Rimouski–Blanc-Sablon

Symbol	Protective Status	Agency Responsible	Number	Area (km²)
Federal jurisdiction (729.2 km²)				
▲	National park	Canadian Heritage (Parks Canada)	1+1 in park reserve	390.40
●	National wildlife area	Environment Canada (Canadian Wildlife Service)	2	7.70
⊙	Migratory bird sanctuary		11	331.10
○	Migratory bird no-hunting zone		2	NA
Provincial jurisdiction (164.03 km²)				
■	Provincial conservation park	Ministère de l'Environnement et de la Faune	2	6.40
★	Ecological reserve		3	48.50
★	Wildlife preserve		1	109.13
			TOTAL	893.23

NA: Not available. The size of no-hunting zones may be repealed, redrawn or modified from year to year.

Note: Some protected areas have a double status and their size may be overestimated.

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State of the Environment

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Vision 2000

Source:
- Boucher, P.R. 1992. *Les milieux naturels protégés au Québec*. Ministère de l'Environnement du Québec, Direction de la conservation et du patrimoine écologique.
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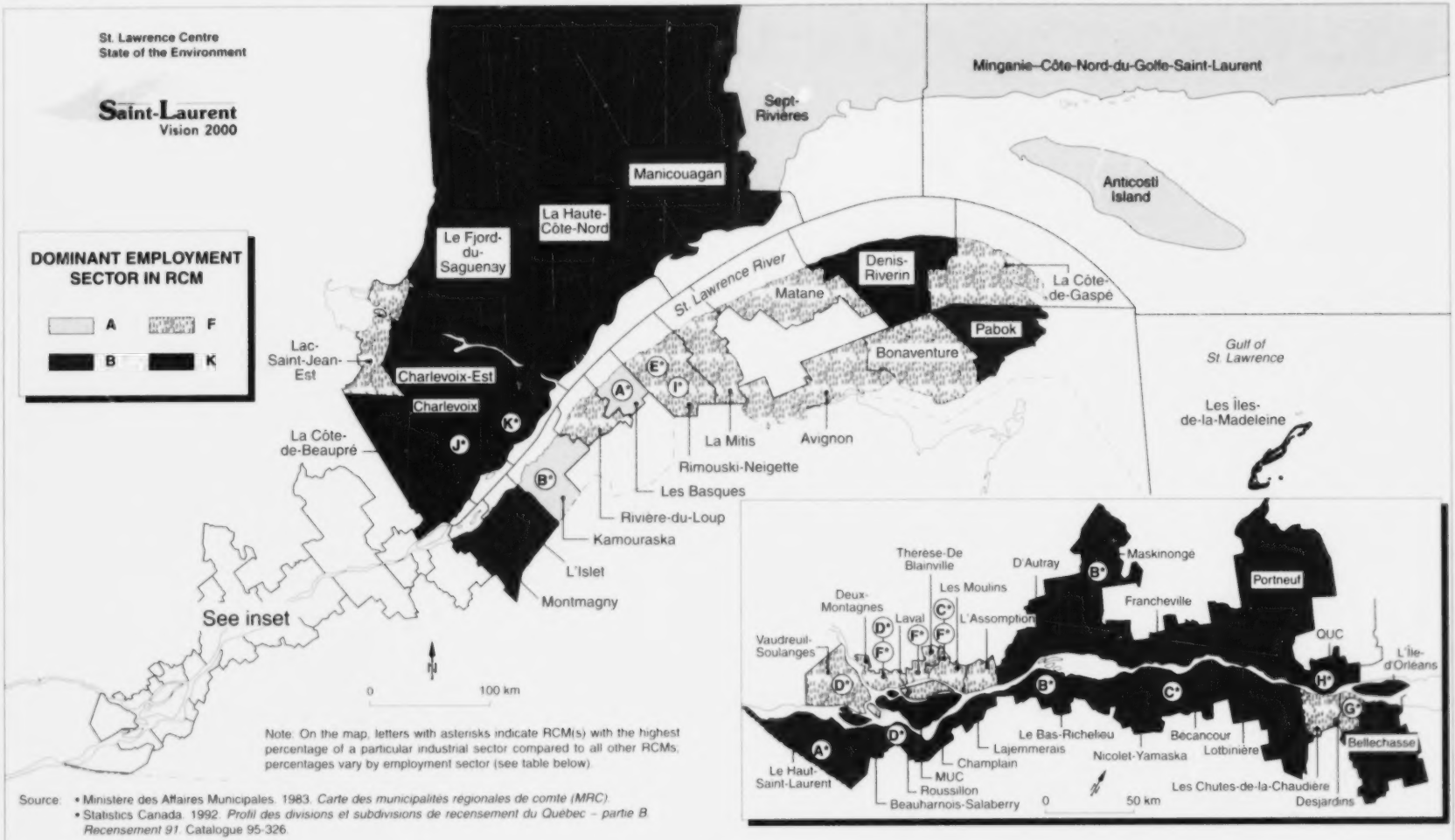
March 1997

INFO-FLASH 9

The St. Lawrence River – Dominant Employment Sector, by Riverside RCM (1991)



Note: On the map, letters with asterisks indicate RCM(s) with the highest percentage of a particular industrial sector compared to all other RCMs; percentages vary by employment sector (see table below).

Source:
- Ministère des Affaires Municipales. 1983. *Carte des municipalités régionales de comté (MRC).*
- Statistics Canada. 1992. *Profil des divisions et subdivisions de recensement du Québec – partie B. Recensement 91.* Catalogue 95-326.

Employment Sector	(%)	Employment Sector	(%)
A. Primary industry (1)	< 1–19	G. Financial, insurance and real estate consultants	2–12
B. Manufacturing industry	6–27	H. Government services	3–17
C. Construction industry	4–11	I. Educational services	3–11
D. Transport and storage industry	2–7	J. Health and social services	5–20
E. Communications and other public services	1–8	K. Other services (3)	11–25
F. Trade industry (2)	14–22		

(1) Agricultural industry and related services; fishing and trapping industry; forestry and forestry services; mining industry; quarries and oil wells.

(2) Wholesale and retail trade.

(3) Business service industry; hotel and restaurant industry; other service industries.

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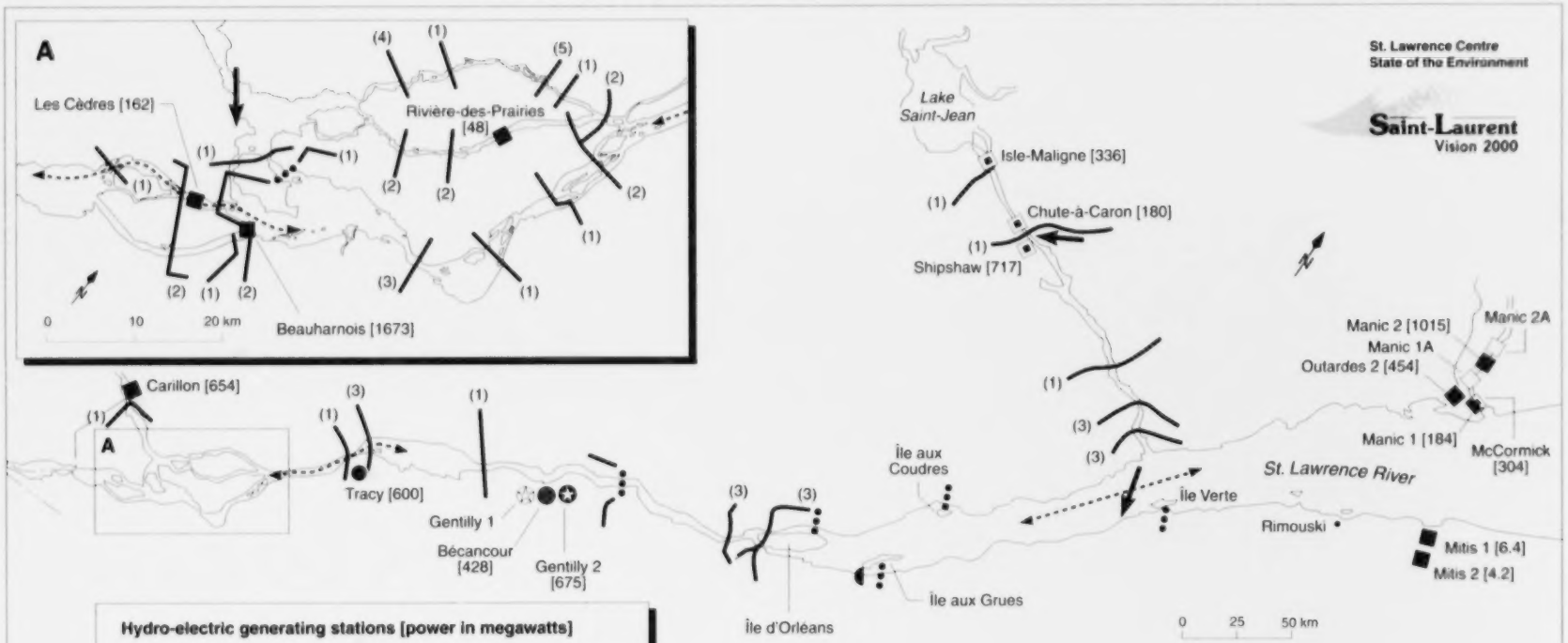
The St. Lawrence River – Energy Production and Transmission



Hydro-electric generating stations [power in megawatts]

- Hydro-electric generating station – 9 stations: 4018 MW
- Hydro-electric generating station* – 4 stations: 1554 MW
- Hydro-electric generating station under study

Thermal generating stations [power in megawatts]

- Classic generating station – 1 station: 600 MW
- Classic or diesel generating station* – 2 stations: 16 MW
- Diesel generating station – 7 stations: 96 MW
- Non-functioning thermal generating station – 3 stations
- Nuclear generating station – 1 station. 675 MW
- Out of service nuclear station*
- Gas turbine generating station – 1 station: 428 MW

Transmission lines

- ( ) Number of lines
- Aerial hydro-electric line – 53 lines
- Underwater hydro-electric line – 6 lines
- Future hydro-electric crossing
- Point of arrival of line under study

* Station not owned by Hydro-Québec

Source: • Hydro-Québec. 1996. *Rapport annuel 1995.*
• Hydro-Québec. 1991. *Caractéristiques d'exploitation des aménagements hydroélectriques privés du Québec.*

Environment Canada Environnement Canada

Canada

March 1997

INFO-FLASH 11

The St. Lawrence River and Wastewater Treatment in Riverside Municipalities (1996)

334 RIVERSIDE MUNICIPALITIES
Total population in 1995: 4 187 190

Connected in whole or in part to a sewer system
231 riverside municipalities
Population: 3 930 870 (94%)

Not connected to a sewer system
103 riverside municipalities
Population: 256 320 (6%)

Not served by a treatment plant in June 1996
89 riverside municipalities
Population: 676 940 (17%)

Served in whole or in part by a treatment plant in June 1996
142 riverside municipalities
Population: 3 253 930 (83%)
92 treatment plants in operation in June 1996

37 fully operational treatment plants (those having received notices of compliance* in June 1996)
43 riverside municipalities
Population: 308 970

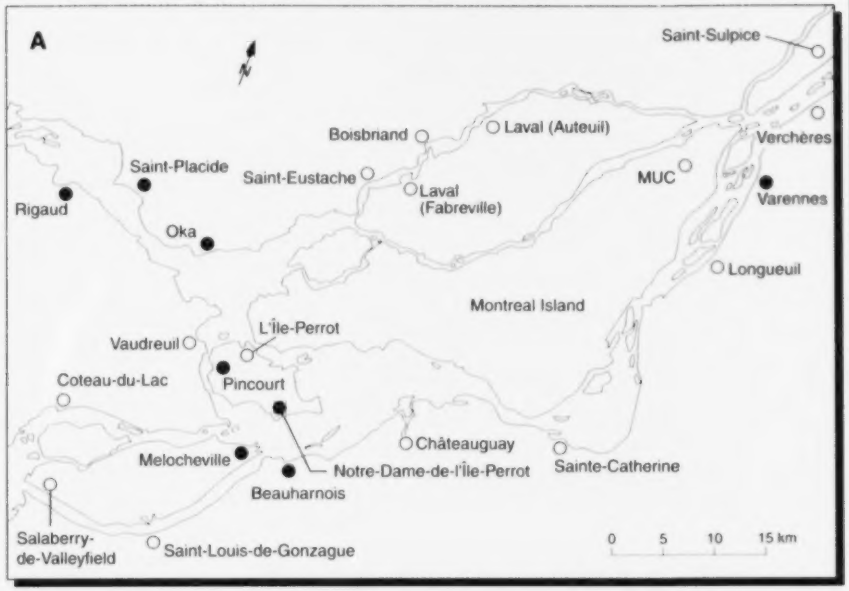
55 treatment plants in run-in phase (those not having received notices of compliance* in June 1996)
99 riverside municipalities
Population: 2 944 960

* Indicates only that, at the moment a notice of compliance is issued, the treatment plant is likely to respect provincial environmental standards. Plants are reassessed every year.

TREATMENT PLANTS UNDER COMPLETION
(Projected to be operational sometime between July 1996 and July 1997)

Baie-Johan-Beetz, Bernières–Saint-Nicolas, Bonne-Espérance, Cap-Santé, L'Islet, Longue-Pointe, Louiseville, Pabos Mills, Repentigny, Rivière-au-Tonnerre, Rosemère, Sacré-Coeur, Sainte-Flavie, Saint-Jean-Baptiste-de-Nicolet, Saint-Siméon (Charlevoix), Sept-Îles (1/2), Terrebonne.

Note: One treatment plant can serve a number of municipalities.



TREATMENT PLANTS IN JUNE, 1996

- ● Fully operational
- ○ In run-in phase

(Numbers in parentheses indicate the number of treatment plants where there exists more than one).

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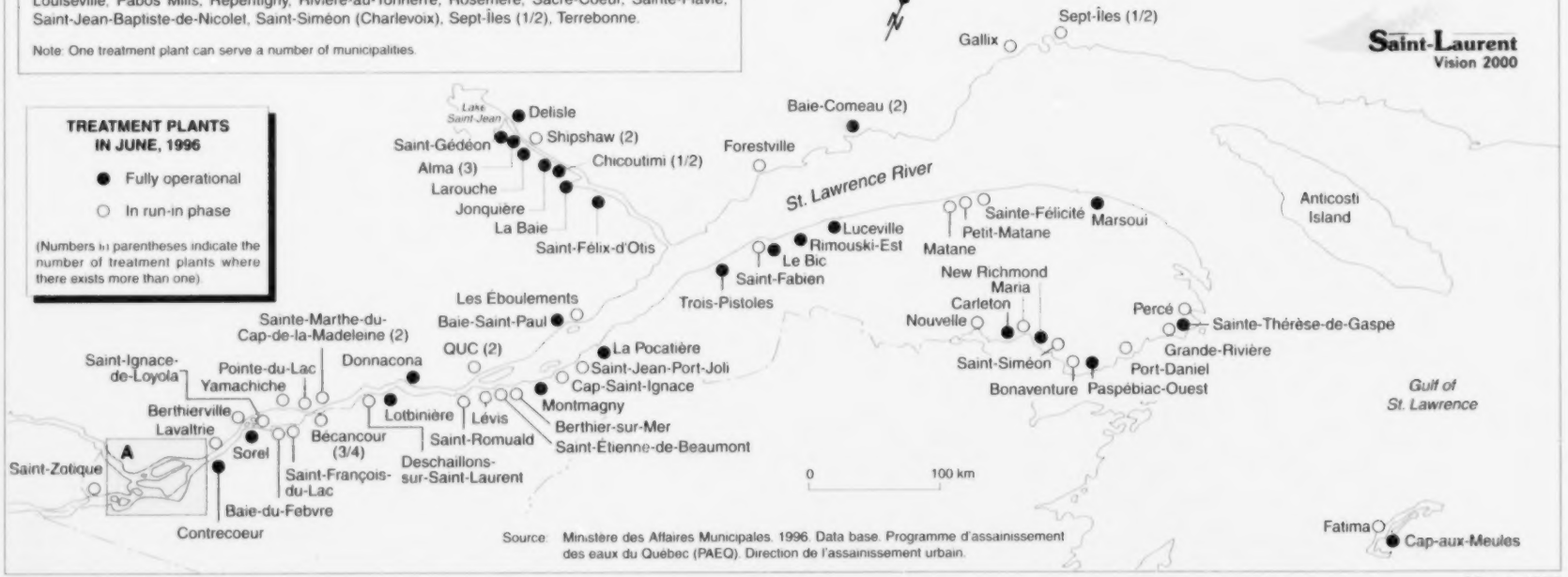

Source: Ministère des Affaires Municipales. 1996. Data base. Programme d'assainissement des eaux du Québec (PAEQ). Direction de l'assainissement urbain.

Environment Canada Environnement Canada

Canada

March 1997

The St. Lawrence River – Overview of Freshwater Sport Fishing (1985)

MAIN SPECIES FISHED, BY SECTOR

MONTREAL SECTOR

	tonnes/yr
Pike spp. (including Muskellunge)	1090
Yellow perch	870
Walleye spp.	600
Bass spp.	40

TROIS-RIVIÈRES SECTOR

	tonnes/yr
Atlantic tomcod	300
Walleye spp.	150
Yellow perch	80
Pike spp. (including Muskellunge)	70

QUEBEC CITY SECTOR

	tonnes/yr
Atlantic tomcod	50
Rainbow smelt	2
Walleye spp.	2

	SPORT FISHERS			FISHING EFFORT			FISHING PRESSURE	FISH HARVEST		
Region studied	Number/yr (> 15-years-old)	% (fluvial section)	% (all of Quebec)	Number of fisher-days	% (fluvial section)	% (all of Quebec)	Fisher-days/ hectare	Landed tonnes/yr	% (fluvial section)	% (all of Quebec)
Montreal sector (69 000 ha)	180 000	**85**	15	2 000 000	**83**	13	29	2 600	**80**	7
Trois-Rivières sector (55 000 ha)	30 500	14	3	390 000	**16**	3	7	600	18	2
Quebec City sector (42 000 ha)	1 500	1	< 1	20 000	1	< 1	0.5	60	2	< 1
Total fluvial section	**212 000**	**100**	**18**	**2 410 000**	**100**	**16**	**15**	**3 260**	**100**	**9**
Province of Quebec	1 082 827	-	-	15 288 000	-	-	ND	35 403	-	-

Note: These figures are estimates of the Ministère du Loisir, de la Chasse et de la Pêche du Québec.

- In 1985, nearly 21% of Quebecers aged 15 and older engaged in sport fishing in Quebec at least once.
- Sport fishers in the freshwater fluvial corridor represent 18% of all sport fishers in Quebec.
- They account for an annual total of 2.4 million fisher-days, or 16% of all fishing in Quebec.
- However, they caught only 9%, by volume, of the total sport-fish harvest in Quebec in 1985.

Source: • Mailhot, Y. 1989. *Pêcheries sportives et commerciales du fleuve Saint-Laurent en eau douce : gestion, récolte et rendement*. Ministère du Loisir, de la Chasse et de la Pêche du Québec. Conference report.
• Ministère du Loisir, de la Chasse et de la Pêche du Québec, and Fisheries and Oceans. 1985. *La pêche récréative au Québec en 1985*.

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Saint-Laurent Vision 2000

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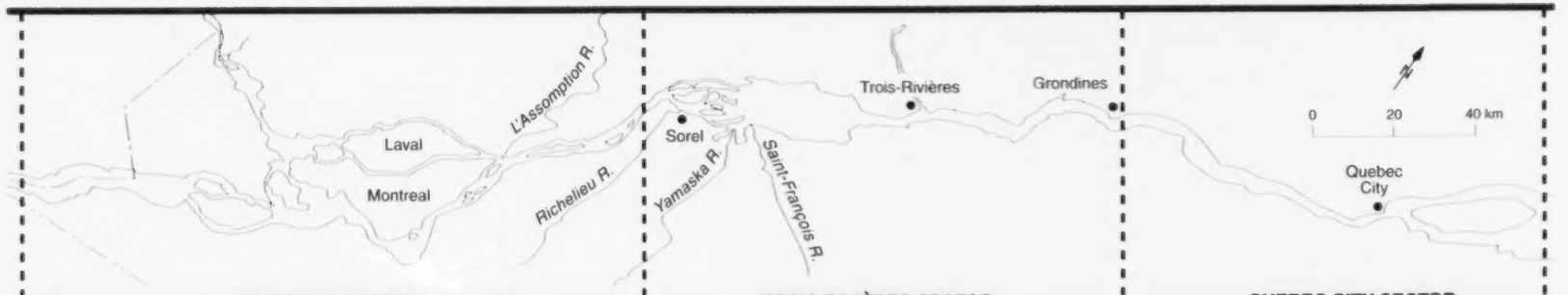
March 1997

INFO-FLASH 12

The St. Lawrence River – Overview of Freshwater Sport Fishing (1985)

MAIN SPECIES FISHED, BY SECTOR



MONTREAL SECTOR

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Bass spp.	40

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Walleye spp.	150
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Pike spp. (including Muskellunge)	70

QUEBEC CITY SECTOR

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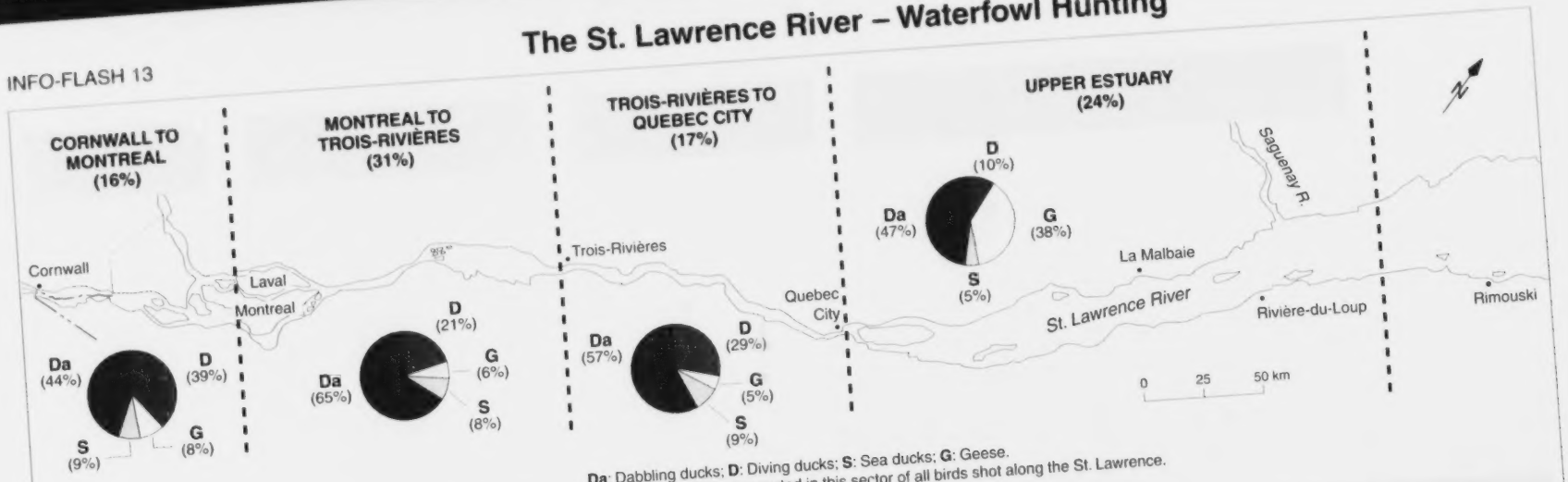
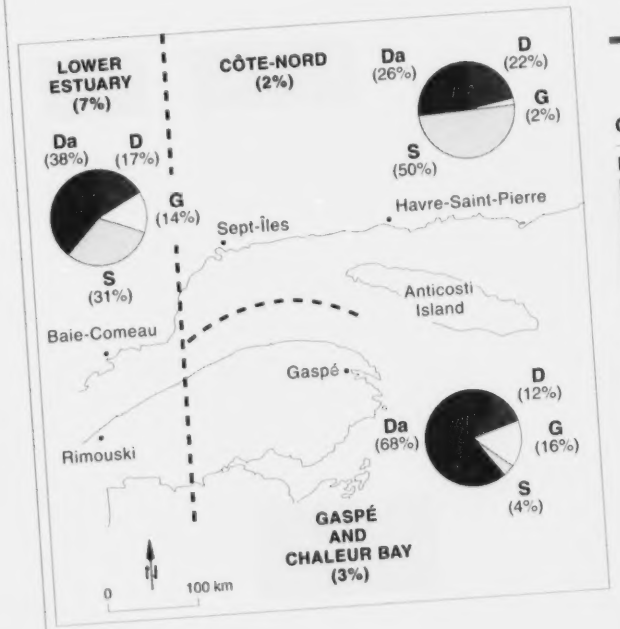
INFO-FLASH 13

The St. Lawrence River – Waterfowl Hunting



Da: Dabbling ducks; **D**: Diving ducks; **S**: Sea ducks; **G**: Geese.

Example: (16%) → percentage of waterfowl harvested in this sector of all birds shot along the St. Lawrence.



MAIN SPECIES OF WATERFOWL HARVESTED ALONG THE RIVER

Group		Number of species harvested	Most-harvested species	Mean % of total waterfowl harvest (1977 to 1981)
Da	Dabbling ducks	9	Black duck	17.8
			Mallard	11.3
			Green-winged teal	9.2
			Pintail	4.5
			Blue-winged teal	4.0
			Other species	6.8
D	Diving ducks	11	Lesser scaup	5.4
			Common goldeneye	5.2
			Greater scaup	4.1
			Ring-necked duck	2.3
			Other species	5.3
G	Geese	4	Greater snow goose	9.0
			Canada goose	5.4
			Other species	0.2
S	Sea ducks	7	Surf scoter	2.2
			Black scoter	2.1
			Oldsquaw	1.9
			Common eider	1.8
			Other species	1.5

Source:
- Lehoux, D., et al. 1985. *La sauvagine dans le système du Saint-Laurent (fleuve, estuaire, golfe)*. Environment Canada, Canadian Wildlife Service.
- Lévesque, H., et al. 1993. "Prise d'oiseaux migrateurs au Canada pendant la saison de chasse de 1991". *Cahiers de biologie*. Environment Canada, Canadian Wildlife Service. No. 204.

QUEBEC'S HUNTERS

THE NUMBER OF MIGRATORY BIRD hunting permits granted increased up until 1980, when it peaked at 76 133. From 1981 to 1991, sales of permits dropped steadily, until only 53 739 permits were sold in 1991, 2% of which were issued to non-residents of Quebec.

QUEBEC'S HARVEST

The average annual waterfowl harvest in Quebec, from 1989 to 1991, was approximately 522 200 birds, mainly dabbling ducks (299 500 or 57%), geese (106 400 or 20%), diving ducks (96 200 or 19%), and sea ducks (20 100 or 4%). Almost all snow geese bagged in Quebec, and 65% of ducks, are shot on the banks of the St. Lawrence River.

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INFO-FLASH 14

The St. Lawrence River – Priority Vascular Plants under SLV 2000 (1995)

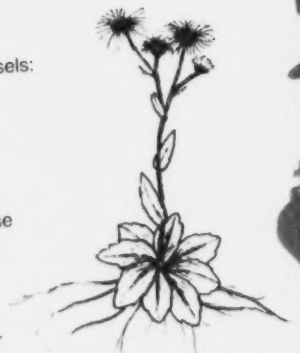
DEFINITIONS

Vascular

Plant having vessels: ferns, horsetails, lycopods and flowering plants.

Priority

Means that these species are the concern of St. Lawrence Vision 2000 for their protection, for their economic value, or for the maintenance of biological diversity.



Erigeron philadelphicus ssp. *provancheri*
(Philadelphia fleabane)

A. Sabourin

Plants in Quebec
9040
known species

Vascular species:
2980

Non-vascular species:
6060

Species likely to be designated threatened or vulnerable in Quebec
374[1]

Species likely to be designated threatened or vulnerable in Quebec
Undetermined number

St. Lawrence Vision 2000 priority species:
110[2]

One tree, six shrubs and 103 herbaceous plants, distributed along a 1-km-wide riparian strip, may be vulnerable due to certain threats (see opposite)

7 species[3] **with a Canada-wide designation**

10 species[1] **endemic to the estuary and Gulf of St. Lawrence (present only in Quebec)**

WHY PROTECT THREATENED OR VULNERABLE SPECIES?

- They may have major economic, recreational, cultural or aesthetic value.
- They are good indicators of the health of our environment and, consequently, our own health.
- They have great potential for maintaining biological diversity for future generations.

HABITATS[4]

- Wetlands (fresh and salt water).
- Marginal environments (cliffs, islands, talus, calcereous rock).
- Forests.
- Open environments (marine barrens, idle land and clearings).

THREATS[4]

- Encroachment on wetlands by:
  - backfilling for development
  - draining, channeling and diking of land for agricultural purposes.
- Pollution of environments with garbage and industrial, municipal, or agricultural wastewater.
- Cottages and recreational activities in the natural riparian environment.
- Deforestation of the shoreline for forestry and agricultural activities.
- Road construction along the shoreline.
- Changes in flow and water levels because of dams.
- Introduction of new species.

These threats can cause often irreversible changes to the biophysical conditions essential to the maintenance of species and their habitats, leading to a loss of habitat and the disappearance of many species.

Source:
1. Lavoie, G. 1992. *Plantes vasculaires susceptibles d'être designees menacees ou vulnerables au Quebec*. Ministère de l'Environnement du Québec, Direction de la conservation et du patrimoine écologique.
2. St. Lawrence Vision 2000. 1995. *Rapport sur les especes de faune et de flore prioritaires au plan d'action Saint-Laurent Vision 2000*. Species technical committee. Presented to the Biodiversity Harmonization Committee.
3. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 1995. *Endangered Species in Canada*. April 1995.
4. Lemay, A.B. 1987. *Analyse descriptive des milieux caractérisant les espèces menacées et vulnérables au Québec*. Prepared for the Ministère de l'Environnement du Québec.

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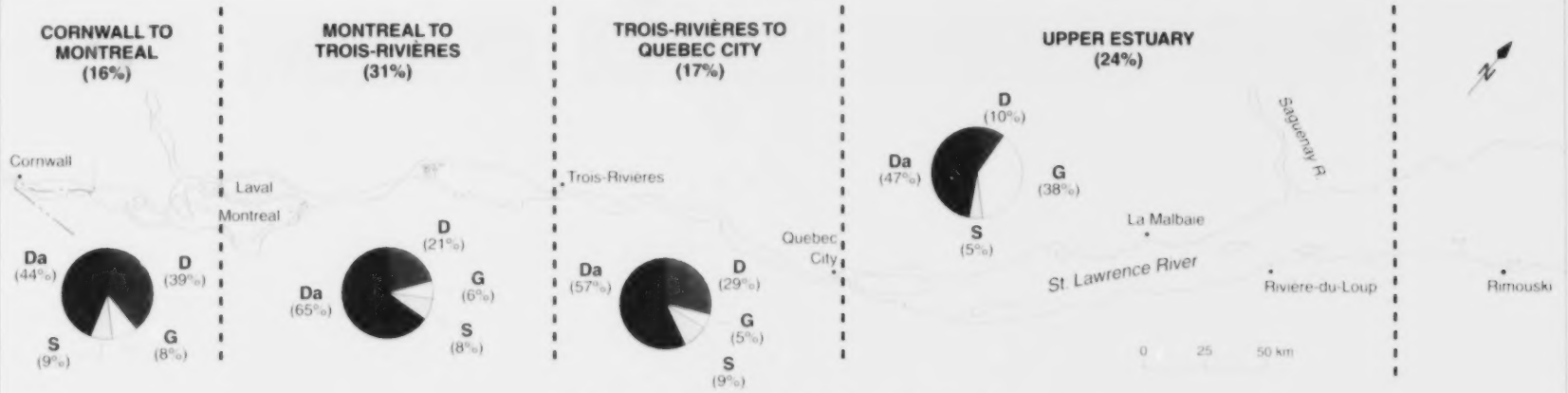
The St. Lawrence River – Waterfowl Hunting



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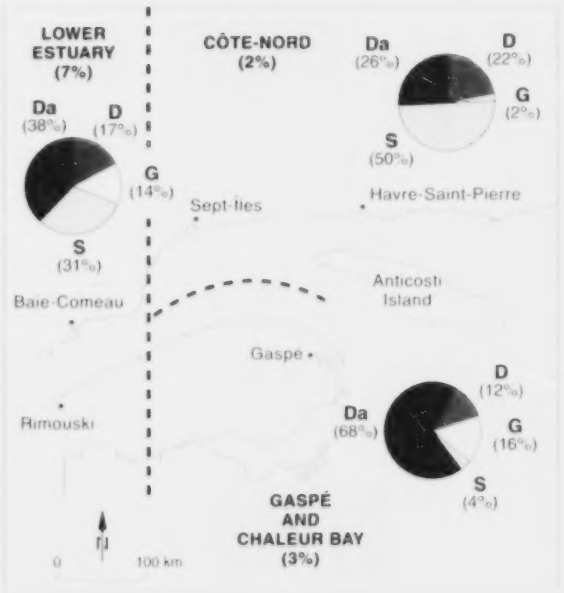

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Canada

March 1997

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Species likely to be designated threatened or vulnerable in Quebec

Undetermined number

St. Lawrence Vision 2000 priority species:

110[2]

One tree, six shrubs and 103 herbaceous plants, distributed along a 1-km-wide riparian strip, may be vulnerable due to certain threats (see opposite)

7 species[3] with a Canada-wide designation

10 species[1] endemic to the estuary and Gulf of St. Lawrence (present only in Quebec)

HABITATS[4]

- Wetlands (fresh and salt water).
- Marginal environments (cliffs, islands, talus, calcereous rock).
- Forests.
- Open environments (marine barrens, idle land and clearings).

THREATS[4]

- Encroachment on wetlands by:
  - backfilling for development
  - draining, channeling and diking of land for agricultural purposes.
- Pollution of environments with garbage and industrial, municipal, or agricultural wastewater.
- Cottages and recreational activities in the natural riparian environment.
- Deforestation of the shoreline for forestry and agricultural activities.
- Road construction along the shoreline.
- Changes in flow and water levels because of dams.
- Introduction of new species.

These threats can cause often irreversible changes to the biophysical conditions essential to the maintenance of species and their habitats, leading to a loss of habitat and the disappearance of many species.

WHY PROTECT THREATENED OR VULNERABLE SPECIES?

- They may have major economic, recreational, cultural or aesthetic value.
- They are good indicators of the health of our environment and, consequently, our own health.
- They have great potential for maintaining biological diversity for future generations.

St. Lawrence Centre
State of the Environment

Saint-Laurent
Vision 2000

Source: 1. Lavoie, G. 1992. *Plantes vasculaires susceptibles d'être désignées menacées ou vulnérables au Québec*. Ministère de l'Environnement du Québec. Direction de la conservation et du patrimoine écologique.
2. St. Lawrence Vision 2000. 1995. *Rapport sur les espèces de faune et de flore prioritaires au plan d'action Saint-Laurent Vision 2000*. Species technical committee. Presented to the Biodiversity Harmonization Committee.
3. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 1995. *Endangered Species in Canada*. April 1995.
4. Lemay, A.B. 1987. *Analyse descriptive des milieux caractérisant les espèces menacées et vulnérables au Québec*. Prepared for the Ministère de l'Environnement du Québec.

Environment Canada Environnement Canada

Canada

March 1997

INFO-FLASH 15

The St. Lawrence River – Priority Vertebrate Wildlife under SLV 2000 (1995)

Class	A. Number of priority species for SLV 2000**	B. Number of species found in Quebec	A/B (%)	Species (Common name)
Fish	14	185	8	American eel American shad Atlantic herring Atlantic sturgeon Atlantic tomcod Brassy minnow Channel darter Copper redhorse* Lake sturgeon Rainbow darter Rainbow smelt Redfin pickerel River redhorse* Striped bass
Amphibia	1	21	5	Northern chorus frog
Reptilia	6	16	38	Blanding's turtle Brown snake Map turtle Spiny softshell turtle* Spotted turtle* Wood turtle
Aves	19	326	6	Barrow's goldeneye Bald eagle Blue-winged teal Caspian tern* Cerulean warbler* Common moorhen Grasshopper sparrow Harlequin duck* Horned grebe Least bittern Le Conte's sparrow Loggerhead shrike* Northern pintail Peregrine falcon* Piping plover* Red-headed woodpecker Roseate tern* Sedge wren Yellow rail
Mammalia	5	90	6	Beluga whale* Fin whale Harbour porpoise* Harbour seal Pygmy shrew
TOTAL	**45**	**638**	**7**	

* Protected species in Canada.
** St. Lawrence Vision 2000 action plan.

St. Lawrence Centre
State of the Environment

Saint-Laurent
Vision 2000

HABITATS

- Aquatic environments: river, estuary, gulf
  - littoral zone (shallow water)
  - pelagic zone (deep water).
- Riparian wetlands (fresh and salt water).
- Marginal environments (cliffs, talus, calcereous rocks).
- Wooded and peaty riparian environments.
- Islands.
- Open riparian environments (marine barrens, idle land, clearings).

THREATS

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- Road construction along the shoreline.
- Changes in flow and water levels because of hydro-electric dams.
- Introduction of new species.
- Commercial shipping and river dredging.

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- St. Lawrence Vision 2000. 1995. *Rapport sur les espèces de faune et de flore prioritaires au plan d'action Saint-Laurent Vision 2000.* Species technical committee. Presented to the Biodiversity Harmonization Committee.

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March 1997

The St. Lawrence River – Overview of Main Federal Sites (1990)

DEPARTMENT OR AGENCY RESPONSIBLE (Number of parcels of land)	USES
TRANSPORT CANADA (603)	• Navigational aids (lighthouses, lights, buoys, triangulation stations). • Coast Guard harbours and wharfs, hydroplane wharfs. • St. Lawrence ship channel. • Buildings and airports. • Communications installations.
PUBLIC WORKS CANADA (248)	• Buildings, land. • Dry docks, slipways. • Protective walls, breakwaters. • Wharfs and wharf access roads.
FISHERIES AND OCEANS (242)	• Fishing harbours. • Pleasure boat harbours. • Laboratories, research institutes. • Various installations (slipways, breakwaters, buildings, land).
ENVIRONMENT CANADA (83)	• Historic sites and monuments. • Forillon National Park and the Mingan Archipelago National Park Reserve. • Miscellaneous parks. • National wildlife areas. • Migratory bird sanctuaries. • Chambly and Lachine canals. • Buildings, miscellaneous land.
NATIONAL DEFENCE (54)	• Canadian Forces bases. • Armories, arsenals. • Firing ranges. • Various buildings and installations.
CANADIAN BROADCASTING CORPORATION (CBC) (47)	• Buildings, miscellaneous land. • Transmitters, radio and television transmitting stations.
INDIAN AND NORTHERN AFFAIRS (16)	• Indian reserves. • Native settlements.
CANADA PORTS CORPORATION (13)	• Ports of Montreal, Trois-Rivières, Quebec City, Sept-Îles and Baie-des-Ha! Ha! • Various wharfs and the Beauport flats.
AGRICULTURE CANADA (6)	• Research stations, laboratories and experimental farms.
CANADIAN NATIONAL (CN) (5)	• Marshalling yards. • Montreal and Quebec City central stations. • Repair shops.
ST. LAWRENCE SEAWAY AUTHORITY (4)	• Beauharnois and Rive Sud canals. • Champlain and Jacques-Cartier bridges (approaches and bridge structures).
ATOMIC ENERGY OF CANADA LTD. (2)	• Gentilly nuclear generating station. • Laprade heavy water plant.
ENERGY, MINES AND RESOURCES CANADA (2)	• Laurentian forestry centre. • Sainte-Foy research station.
NATIONAL RESEARCH COUNCIL OF CANADA (2)	• Research institutes.
EIGHT OTHER FEDERAL DEPARTMENTS OR AGENCIES (252)	• Miscellaneous buildings or land. • Communications installations. • Post offices. • Penitentiaries.

TOTAL: 1579* parcels of land, or approximately 1500 km²

* This figure is an approximation, since we had to complete the federal lands database using other sources of information. For each site so added, we accounted for only one parcel per site, when in reality it may consist of several more (the exact number being unavailable).

St. Lawrence Centre
State of the Environment

Source: • Environment Canada. 1988. Federal lands database.
• Fisheries and Oceans. 1984. Chart of small-craft harbours.
• Gauthier et Guillemette Consultants Inc. 1990. *Inventaire et caractérisation des principales installations fédérales au Québec*. For Environment Canada.

Saint-Laurent Vision 2000

Environment Canada Environnement Canada

Canada

March 1997

INFO-FLASH 15

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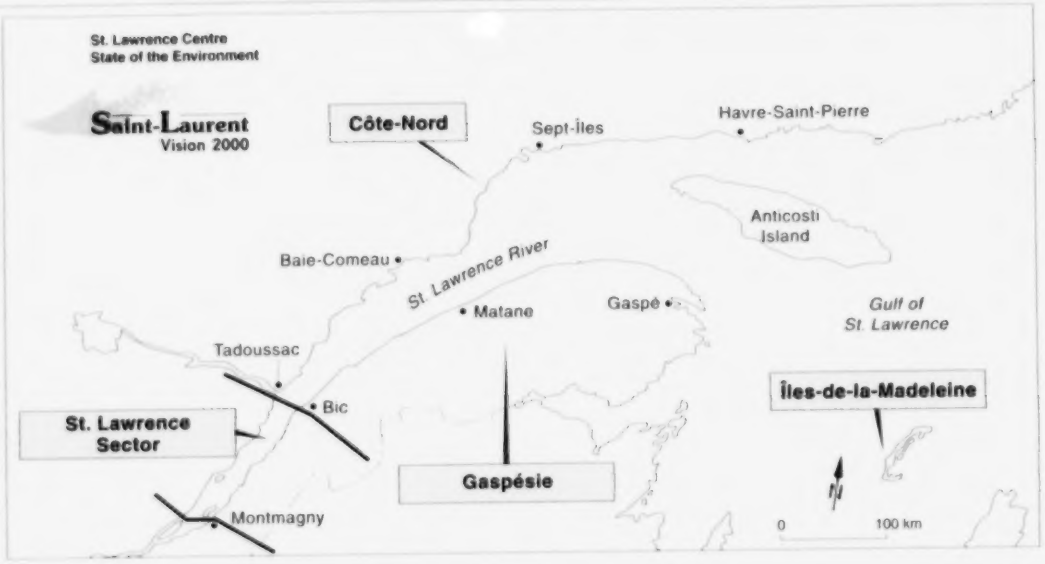
March 1997

INFO-FLASH 17

The St. Lawrence River – Commercial Marine Fishery: Economic Aspects



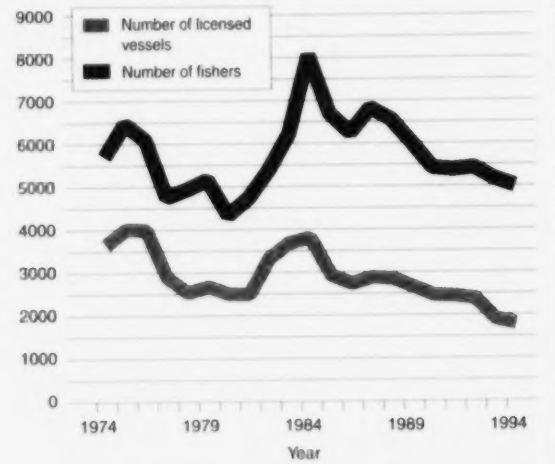
COMMERCIAL FISHING BY REGION (1994)

	St. Lawrence sector*	Côte-Nord	Gaspésie	Îles-de-la-Madeleine	TOTAL
Number of fishers	94	1 460	2 150	1 290	4 994
(%)	(2)	(29)	(43)	(26)	(100)
Number of active Quebec vessels/ Number of licensed vessels**	18/ 31	339/ 649	482/ 687	401/ 419	1 209***/ 1 786
Landings					
• **Quantity in tonnes**	746	11 395	24 783	14 298	51 222****
(%)	(1)	(22)	(48)	(28)	(100)
• **Value in $ millions**	2.2	34.8	64.3	28.7	130.0
(%)	(2)	(27)	(49)	(22)	(100)
Maximum number of factory or fish plant employees	221	1 035	1 697	1 109	4 062
(%)	(5)	(26)	(42)	(15)	(100)
Plant production in tonnes	7 788	5 462	13 197	9 041	35 488
(%)	(22)	(15)	(37)	(26)	(100)

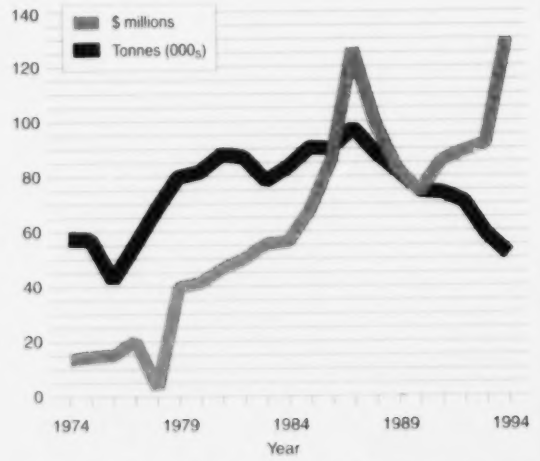
* May include data from non-marine regions (e.g. Montreal or Quebec City).
** All vessels having made at least one landing in a particular region.
*** A vessel may be active in more than one area, but it is only counted once in the total.
**** Also includes 19 tonnes of other species (seals, sea urchins, mosses, algae, etc.).

COMMERCIAL FISHING FROM 1974 TO 1994

FISHERS AND VESSELS



LANDINGS OF FISH, SHELLFISH AND CRUSTACEANS****



Source: • Bérubé, Z. 1990. *La pêche maritime au Québec, 1956-1985*. Bureau de la statistique du Québec.
• Fisheries and Oceans. *Les pêches maritimes du Québec. Revue statistique*. 1984-87, 1987-88, 1988-89, 1989-90, 1990-91, 1991-92, 1992-93, 1993-94 editions.

March 1997

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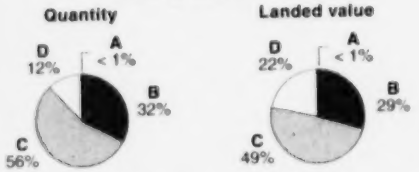
The St. Lawrence River – Commercial Marine Fishery: Species Harvested in 1994

OVERVIEW OF FISHERIES BY CATEGORY OF SPECIES (1994)

SHELLFISH AND CRUSTACEANS

63% of total volume (32 189 tonnes)
91% of total value ($117.8 million)

REGIONAL DISTRIBUTION



MOST IMPORTANT SPECIES

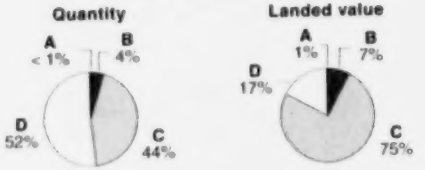
	Quantity	Value
Snow crab	46%	62%
Shrimp	32%	12%
Lobster	10%	22%
Scallops	8%	4%

Other species fished: Soft-shell clams, whelks, mussels, clams.

GROUNDFISH

17% of total volume (8888 tonnes)
6% of total volume ($7.8 million)

REGIONAL DISTRIBUTION



MOST IMPORTANT SPECIES

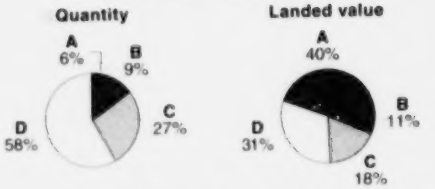
	Quantity	Value
Redfish	53%	16%
Greenland halibut	36%	63%
Cod	4%	5%
Plaice	2%	4%

Other species fished: White hake, Atlantic halibut, Atlantic wolffish, lumpsucker, skate.

PELAGIC AND ESTUARINE FISH

20% of total volume (10 126 tonnes)
3% of total volume ($4.4 million)

REGIONAL DISTRIBUTION



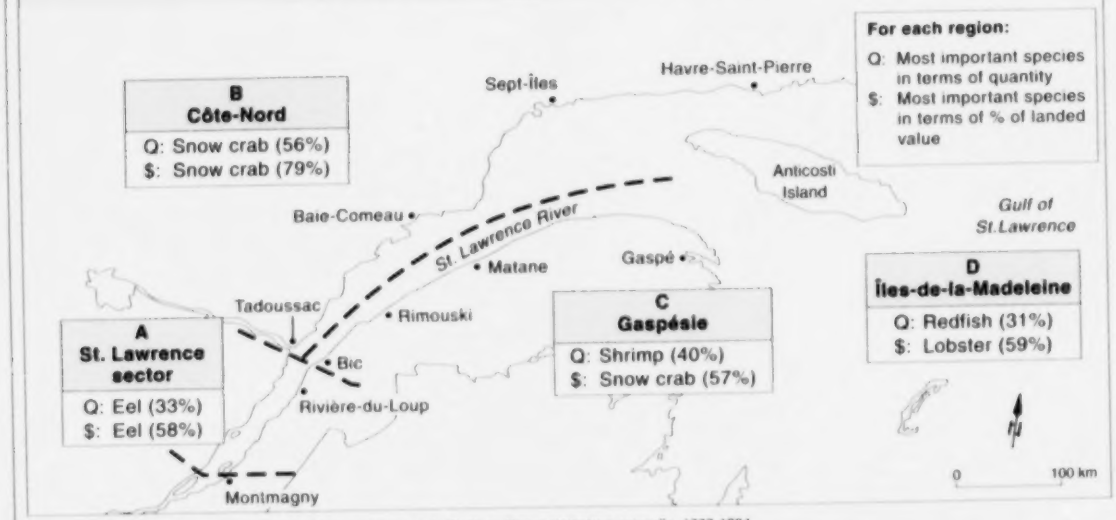
MOST IMPORTANT SPECIES

	Quantity	Value
Herring	54%	27%
Mackerel	35%	23%
Capelin	3%	1%
Eel	1%	29%

Other species fished: Smelt, salmon, other pelagic species (walleye, pike, bass, etc.).

A: St. Lawrence sector B: Côte-Nord C: Gaspésie D: Îles-de-la-Madeleine

MOST IMPORTANT SPECIES BY REGION IN 1994



MOST IMPORTANT SPECIES, ALL REGIONS

	Quantity		Landed value	
1	Snow crab	29%	Snow crab	56%
2	Shrimp	20%	Lobster	20%
3	Herring	11%	Shrimp	11%
4	Redfish	9%	Greenland halibut	4%
5	Mackerel	7%	Scallops	3%
	Other species	24%	Other species	6%

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Saint-Laurent Vision 2000

Source: Fisheries and Oceans. 1995. *Les pêches maritimes du Québec. Revue statistique annuelle, 1993-1994.*

March 1997

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19-20

M121

IMPORTANT NOTE CONCERNING THE FOLLOWING PAGES

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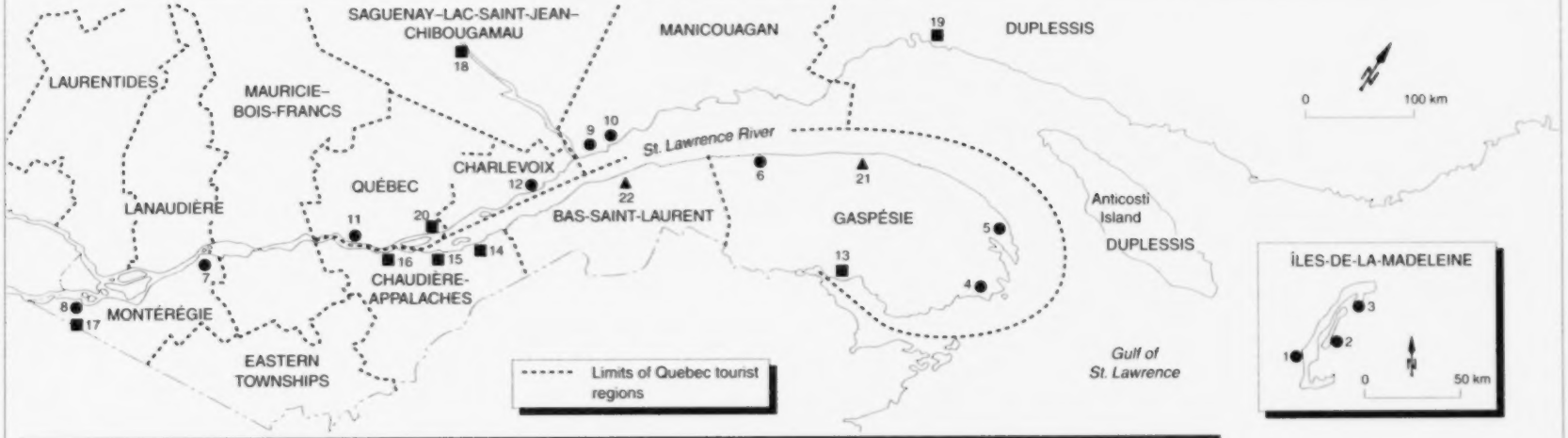
The St. Lawrence River – Festivals (1996–97)



	Symbol		Name of festival	Municipality	Tourist region	Season (month)
Festivals linked to a marine resource or to commercial or sport fishing	●	1	Fishermen's festival	Étang-du-Nord	Îles-de-la-Madeleine	Summer (July)
		2	Seafood festival	Havre-aux-Maisons	Îles-de-la-Madeleine	Summer (July)
		3	Island lobster festival	Grande-Entrée	Îles-de-la-Madeleine	Summer (July)
		4	Regional, industrial and commercial exhibition (focused on fishing)	Grande-Rivière	Gaspésie	Spring (May)
		5	Folklore festival	Rivière-au-Renard	Gaspésie	Summer (late August)
		6	Shrimp festival	Matane	Gaspésie	Summer (late June)
		7	Fish stew festival	Sorel	Montérégie	Summer (July)
		8	Trout festival	Valleyfield	Montérégie	Spring (June)
		9	Blue whale festival	Grandes-Bergeronnes	Manicouagan	Summer (August)
		10	Esco-crab festival	Les Escoumins	Manicouagan	Spring (mid-May)
		11	Salmon festival	Donnacona	Québec	Summer (June)
		12	Festival of natural sciences	Saint-Fidèle-de-Mont-Murray	Charlevoix	Summer (June-August)
Festivals linked to a recreational activity (other than fishing) or a wildlife resource related to water (e.g. geese, ducks)	■	13	Sailing festival	Carleton	Gaspésie	Summer (August)
		14	Festival of Saint-Hubert	Cap-Saint-Ignace	Chaudière-Appalaches	Summer (early September)
		15	Snow goose festival	Montmagny	Chaudière-Appalaches	Fall (October)
		16	Water festival	Saint-Romuald	Chaudière-Appalaches	Spring (June)
		17	Valleyfield regatta	Valleyfield	Montérégie	Summer (July)
		18	Alma rowing festival	Alma	Saguenay–Lac-Saint-Jean–Chibougamau	Summer (July)
		19	Sept-Îles annual boating festivities	Sept-Îles	Duplessis	Summer (July)
		20	Snow goose festival	Saint-Joachim	Québec	Fall (October)
Festivals linked to the history or geography of a site	▲	21	Hang-gliding festival	Mont Saint-Pierre	Gaspésie	Summer (July-August)
		22	Festival of the isles	Trois-Pistoles	Bas-Saint-Laurent	Summer (July)

There were an additional 45 festivals held in riverside municipalities in 1996–97.

These 45 festivals were not linked directly to the St. Lawrence, but sometimes feature river-related activities (e.g. the canoe race on river ice at the Quebec City Carnaval).

These festivals are varied in nature and focus on such themes as:

- industrial activities
- agricultural or commercial activities (other than fishing)
- song, theatre, film, poetry, music
- folklore, youth
- local or regional foods
- a season (fall, winter, etc.).

Source:
- Ministère du Tourisme du Québec and regional tourism associations. Regional tourism guides, 1995-97 editions.
- Société des Fêtes et Festivals du Québec, Société des Attractions touristiques du Québec, and Ministère des Affaires Municipales. 1996. *Guide Festivals et Attractions touristiques au Québec 1996-1997*. Tourisme Québec. "Cartes routières et répertoires" collection.

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Saint-Laurent Vision 2000

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March 1997

INFO-FLASH 20

The St. Lawrence River – Toponymy of Main Islands and Archipelagos

FLUVIAL SECTION

- 1 Île de Salaberry
- 1 Île Perrot
- 2 Montreal Island
- 4 de la Paix islands (7)
- 4 Île des Soeurs
- 1-6 Île Sainte-Hélène
- 4 Île Notre-Dame

ONTARIO

Cornwall

Montreal

- 1-5 Boucherville islands (15)
- 1-5 Varennes islands (18)
- 1-5 Verchères islands (10)
- 1-5 Contrecoeur islands (29)
- 5 Lake Saint-Pierre archipelago (57)
- 3 Île aux Sternes

ESTUARY

Fluvial

- 1 Île Bougainville
- 1 Île La Poterie
- 1 Île Saint-Quentin
- 1 Île d'Orléans

Trois-Rivières

Quebec City

0 50 km

Legend

- 1 See below
- (19) Approximate number of islands

Upper

Saguenay R.

- 3 l'Isle-aux-Grues archipelago (21)
- 3 Île aux Coudres

Rivière-du-Loup

- 5-9 Kamouraska islands (11)
- 2 Les Pèlerins (5)
- 2 Îles du Pot à l'Eau-de-Vie (3)
- 3 Île aux Lièvres
- 5-9 Rocher de Cacouna
- 2 Île Verte

Lower

Baie-Comeau

Rimouski

Matane

- 4-7 Île aux Basques
- 3 Île aux Pommes
- 8 Île Razade d'en Haut
- 5 Île du Bic
- 6 Île Saint-Barnabé
- 1 Îlets Jérémie
- 2 Les Trois Soeurs (3)
- 2 Penchées islands (4)

NUMBER OF ISLANDS

Section	Number
FLUVIAL SECTION	330
ESTUARY	
Fluvial	20
Upper	70
Lower	60
GULF	770
TOTAL	1250*

* This number is an approximation. The total excludes the des Prairies and Mille Îles rivers and Lake des Deux Montagnes.

TOPONYMY OF MAIN ISLANDS

- 1 Personages
- 2 Form, appearance, colour
- 3 Plant or animal life
- 4 Historical facts and anecdotes
- 5 Riparian locations
- 6 Saints' names
- 7 Shipping, fishing, maritime life
- 8 Geographical location
- 9 Native Indian name

GULF

- 2-5 Sept Îles archipelago (7)
- 2-9 Mingan archipelago (40)
- 2-9 Washicoutai archipelago (180)
- 2-9 Ouapitagone archipelago (85)
- 6 Sainte-Marie archipelago (60)
- 2-9 Petit Mécatina archipelago (20)
- 2-9 Gros Mécatina archipelago (60)
- 3-9 Kécarpoui archipelago (60)
- 1-6 Saint-Augustin archipelago (40)
- 4-8 Vieux Fort archipelago (100)
- 2-4 Blanc-Sablon archipelago (10)

Sept-Îles

Anticosti Island

Gulf of St. Lawrence

Matane

Gaspé

- 8-9 Anticosti Island
- 4-7 Bonaventure Island
- 2 Rocher Percé
- 1 Îles de la Madeleine (24)

0 100 km

Source:
- Commission de Toponymie du Québec. 1984. *Itinéraire toponymique du Saint-Laurent, ses rives et ses îles. Etudes et recherches toponymiques 9.*
- De Repentigny, L.-G. 1996. *Fichier insulaire du Saint-Laurent.* Canadian Wildlife Service.
- EAT Environnement. 1990. *Îles de Cornwall au lac Saint-Pierre.* Prepared for the Canadian Wildlife Service.
- Energy, Mines and Resources Canada. Topographical maps scale 1:50 000.
- Ouellet, C. 1984. *Autour des îles du Saint-Laurent.* Ministère des Affaires Culturelles.

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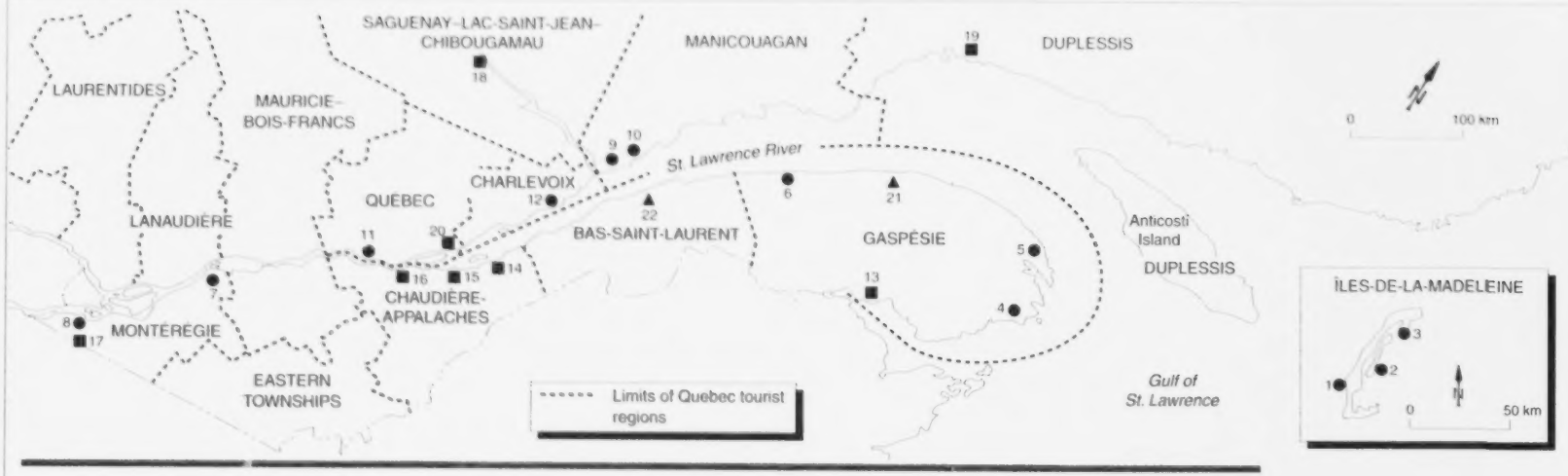
March 1997

The St. Lawrence River – Festivals (1996–97)



	Symbol	Name of festival	Municipality	Tourist region	Season (month)
Festivals linked to a marine resource or to commercial or sport fishing	● 1	Fishermen's festival	Étang-du-Nord	Îles-de-la-Madeleine	Summer (July)
	2	Seafood festival	Havre-aux-Maisons	Îles-de-la-Madeleine	Summer (July)
	3	Island lobster festival	Grande-Entrée	Îles-de-la-Madeleine	Summer (July)
	4	Regional, industrial and commercial exhibition (focused on fishing)	Grande-Rivière	Gaspésie	Spring (May)
	5	Folklore festival	Rivière-au-Renard	Gaspésie	Summer (late August)
	6	Shrimp festival	Matane	Gaspésie	Summer (late June)
	7	Fish stew festival	Sorel	Montérégie	Summer (July)
	8	Trout festival	Valleyfield	Montérégie	Spring (June)
	9	Blue whale festival	Grandes-Bergeronnes	Manicouagan	Summer (August)
	10	Esco-crab festival	Les Escoumins	Manicouagan	Spring (mid-May)
	11	Salmon festival	Donnacona	Québec	Summer (June)
	12	Festival of natural sciences	Saint-Fidèle-de-Mont-Murray	Charlevoix	Summer (June-August)
Festivals linked to a recreational activity (other than fishing) or a wildlife resource related to water (e.g. geese, ducks)	■ 13	Sailing festival	Carleton	Gaspésie	Summer (August)
	14	Festival of Saint-Hubert	Cap-Saint-Ignace	Chaudière-Appalaches	Summer (early September)
	15	Snow goose festival	Montmagny	Chaudière-Appalaches	Fall (October)
	16	Water festival	Saint-Romuald	Chaudière-Appalaches	Spring (June)
	17	Valleyfield regatta	Valleyfield	Montérégie	Summer (July)
	18	Alma rowing festival	Alma	Saguenay–Lac-Saint-Jean–Chibougamau	Summer (July)
	19	Sept-Îles annual boating festivities	Sept-Îles	Duplessis	Summer (July)
	20	Snow goose festival	Saint-Joachim	Québec	Fall (October)
Festivals linked to the history or geography of a site	▲ 21	Hang-gliding festival	Mont Saint-Pierre	Gaspésie	Summer (July-August)
	22	Festival of the isles	Trois-Pistoles	Bas-Saint-Laurent	Summer (July)

There were an additional 45 festivals held in riverside municipalities in 1996–97.

These 45 festivals were not linked directly to the St. Lawrence, but sometimes feature river-related activities (e.g. the canoe race on river ice at the Quebec City Carnaval).

These festivals are varied in nature and focus on such themes as:

- industrial activities
- agricultural or commercial activities (other than fishing)
- song, theatre, film, poetry, music
- folklore, youth
- local or regional foods
- a season (fall, winter, etc.).

Source:
- Ministère du Tourisme du Québec and regional tourism associations. Regional tourism guides, 1995-97 editions.
- Société des Fêtes et Festivals du Québec, Société des Attractions touristiques du Québec, and Ministère des Affaires Municipales. 1996. *Guide Festivals et Attractions touristiques au Québec 1996-1997*. Tourisme Québec. "Cartes routières et répertoires" collection.

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March 1997

The St. Lawrence River – Toponymy of Main Islands and Archipelagos

FLUVIAL SECTION

- 1 Île de Salaberry
- 1 Île Perrot
- 2 Montreal Island
- 4 de la Paix islands (7)
- 4 Île des Soeurs
- 1-6 Île Sainte-Hélène
- 4 Île Notre-Dame
- 1-5 Boucherville islands (15)
- 1-5 Varennes islands (18)
- 1-5 Verchères islands (10)
- 1-5 Contrecoeur islands (29)
- 5 Lake Saint-Pierre archipelago (57)
- 3 Île aux Sternes

ESTUARY

Fluvial

- 1 Île Bougainville
- 1 Île La Poterie
- 1 Île Saint-Quentin
- 1 Île d'Orléans

Legend

- 1 See below
- (19) Approximate number of islands

Upper

- 3 l'Isle-aux-Grues archipelago (21)
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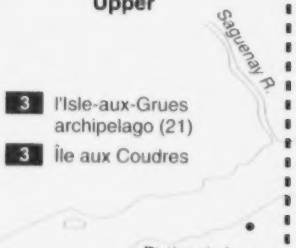

Lower

- 4-7 Île aux Basques
- 3 Île aux Pommes
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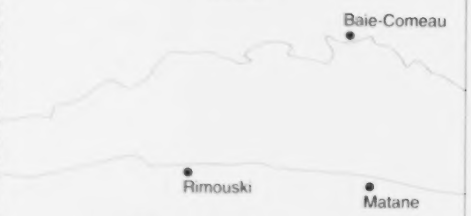

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The St. Lawrence River – Waterfowl from Cornwall to Tadoussac

LIST OF SPECIES

Geese (A)	Dabbling ducks (B)	Diving ducks (C)	Sea ducks (D)
Snow goose	Black duck	Scaups, Ring-necks	Eider spp.
Brant	Mallard	Common goldeneye	Oldsquaw
Canada goose	Northern pintail	Merganser spp.	Scoter spp.
	Northern shoveler		
	Gadwall		
	American wigeon		
	Wood duck		
	Green-winged teal		
	Blue-winged teal		

ESTIMATED WATERFOWL POPULATION, BY SECTOR, BETWEEN 1974 AND 1978

ST. LAWRENCE TOTAL

	Spring	Fall	Winter
A	395 120	211 260	–
B	54 430	136 350	6 475
C	80 860	215 630	25 640
D	193 520	102 510	184 236
Total	**723 930**	**665 750**	**216 351**

UPPER ESTUARY

	Spring	Fall
A	176 570	206 830
B	11 000	57 000
C	1 850	5 380
D	1 210	690
Total	**190 630**	**269 900**

MONTREAL–SOREL

	Spring	Fall
A	3 620	–
B	2 000	7 700
C	3 350	50
D	–	–
Total	**8 970**	**7 750**

LAKE SAINT-PIERRE

	Spring	Fall
A	109 300	50
B	17 000	12 000
C	4 040	59 900
D	–	2 310
Total	**130 340**	**74 260**

LAKE SAINT-PIERRE–QUEBEC CITY

	Spring	Fall
A	14 920	130
B	2 300	19 700
C	2 690	21 160
D	10	330
Total	**19 920**	**41 320**

LOWER ESTUARY

	Spring	Fall	Winter
A	69 000	250	–
B	11 000	12 000	420
C	1 960	1 340	4 406
D	18 550	3 000	301
Total	**100 520**	**16 590**	**5 127**

LAKE DES DEUX MONTAGNES

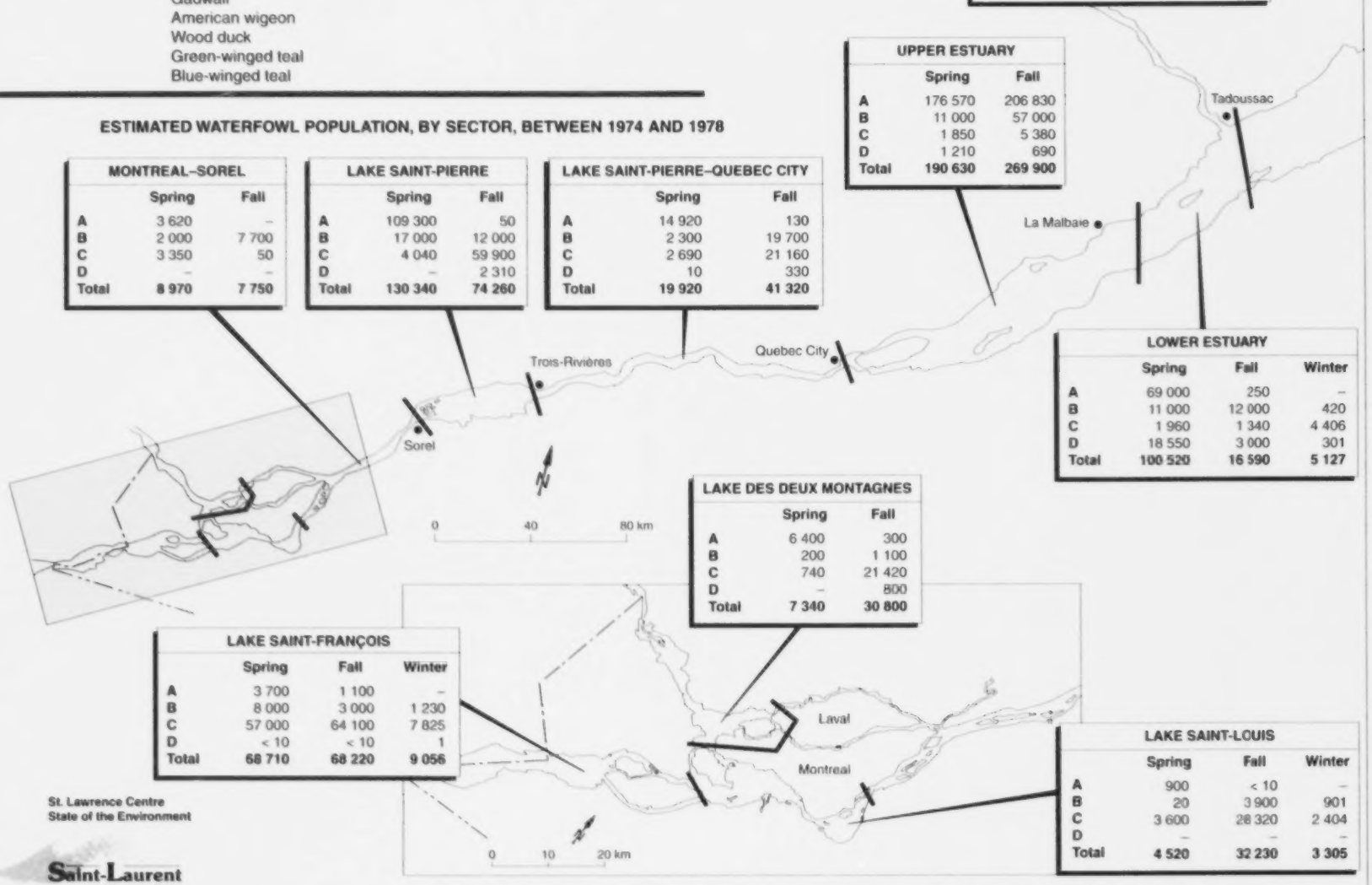
	Spring	Fall
A	6 400	300
B	200	1 100
C	740	21 420
D	–	800
Total	**7 340**	**30 800**

LAKE SAINT-FRANÇOIS

	Spring	Fall	Winter
A	3 700	1 100	–
B	8 000	3 000	1 230
C	57 000	64 100	7 825
D	< 10	< 10	1
Total	**68 710**	**68 220**	**9 056**

LAKE SAINT-LOUIS

	Spring	Fall	Winter
A	900	< 10	–
B	20	3 900	901
C	3 600	28 320	2 404
D	–	–	–
Total	**4 520**	**32 230**	**3 305**



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Source: Lehoux, D. et al. 1985. *La sauvagine dans le système du Saint-Laurent (fleuve, estuaire, golfe)*. Environment Canada, Canadian Wildlife Service.

Environment Canada Environnement Canada

Canada

March 1997

The St. Lawrence River – Waterfowl from Tadoussac to Blanc-Sablon

St. Lawrence Centre
State of the Environment

Saint-Laurent
Vision 2000

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Brant	Mallard	Common goldeneye	Oldsquaw
Canada goose	Northern pintail	Merganser spp.	Scoter spp.
	Northern shoveler		
	Gadwall		
	American wigeon		
	Wood duck		
	Green-winged teal		
	Blue-winged teal		

ESTIMATED WATERFOWL POPULATION, BY SECTOR, BETWEEN 1974 AND 1978

HAUTE-CÔTE-NORD

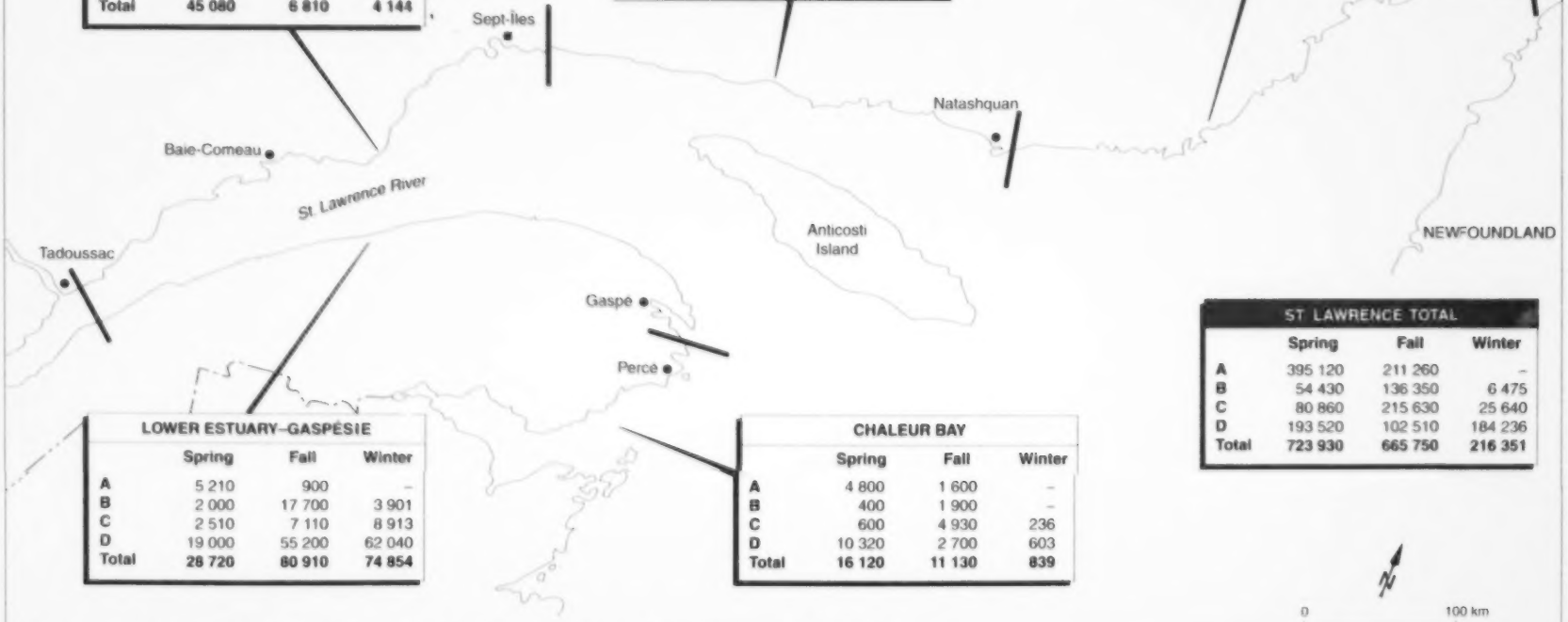
	Spring	Fall	Winter
A	300	90	–
B	500	300	–
C	2 110	1 120	442
D	42 170	5 300	3 702
Total	**45 080**	**6 810**	**4 144**

MOYENNE-CÔTE-NORD

	Spring	Fall	Winter
A	400	–	–
B	–	–	3
C	410	730	1 404
D	102 240	24 520	116 680
Total	**103 050**	**25 250**	**118 087**

BASSE-CÔTE-NORD

	Spring	Fall	Winter
A	–	–	–
B	< 10	50	20
C	–	60	10
D	–	450	909
Total	**10**	**560**	**939**



LOWER ESTUARY–GASPÉSIE

	Spring	Fall	Winter
A	5 210	900	–
B	2 000	17 700	3 901
C	2 510	7 110	8 913
D	19 000	55 200	62 040
Total	**28 720**	**80 910**	**74 854**

CHALEUR BAY

	Spring	Fall	Winter
A	4 800	1 600	–
B	400	1 900	–
C	600	4 930	236
D	10 320	2 700	603
Total	**16 120**	**11 130**	**839**

ST. LAWRENCE TOTAL

	Spring	Fall	Winter
A	395 120	211 260	–
B	54 430	136 350	6 475
C	80 860	215 630	25 640
D	193 520	102 510	184 236
Total	**723 930**	**665 750**	**216 351**

Source: Lehoux, D. et al. 1985. *La sauvagine dans le systeme du Saint-Laurent (fleuve, estuaire, golfe).* Environment Canada, Canadian Wildlife Service.

Environment Canada Environnement Canada

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March 1997

INFO-FLASH 22

The St. Lawrence River – Characterization of Spawning Grounds: Cornwall–Montmagny

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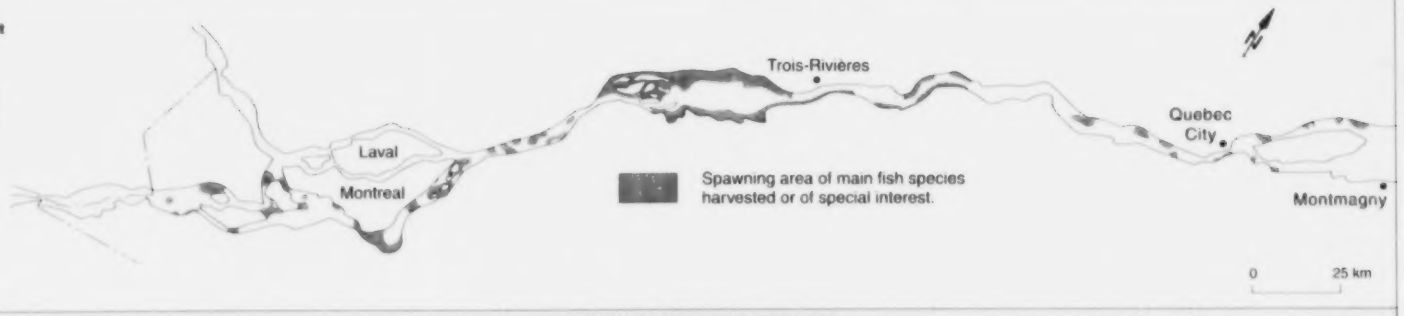


SPECIES	LOCATION OF SPAWNING GROUNDS
1 Lake whitefish	
2 Rainbow smelt	
3 Rock bass	
4 Yellow perch	
5 White sucker	
6 Pumpkinseed	
7 Northern pike	
8 Brown bullhead	
9 Black crappie	
10 Longnose sucker	
11 Lake sturgeon	
12 American shad	
13 Walleye spp.	
14 Channel catfish	
15 Sucker spp.	
16 Brook charr	
17 Atlantic tomcod	
18 Copper redhorse	

CHARACTERIZATION OF SPAWNING HABITATS

Species	Current (cm/s)	Depth (m)	Substrate*	Vegetation**	Temperature (°C)
Lake whitefish	0–200	0.0–7.0	SaGR	N	2–10
Rock bass	0–40	0.0–2.0	CSaGR	SH	15–21
Yellow perch	0–20	0.5–3.0	SCSaG	SHL,HESA	7–12
White sucker	0–110	0.3–2.3	SaGR	N	9–18
Pumpkinseed	0–20	0.1–0.3	CSaGR	SH	20–28
Northern pike	0–20	0.1–1.2	SC	SHL	4–15
Brown bullhead	0–60	0.1–1.2	SCSaG	HESA,SH	16–26
Black crappie	0–20	0.2–2.5	SSaG	HESA,SH	18–20
Longnose sucker	0–45	0.1–0.3	SaGSi	NC	5–18
Lake sturgeon	≥ 10	0.6–4.0	SaGR	N	8–18
American shad	≥ 20	0.5–2.0	SaGSi	N	12–18
Walleye spp.	0–200	0.1–1.5	SaGR	NC	3–11
Channel catfish	0–60	0.6–1.8	SSa	SH	20–30
Brook charr	≥ 20	0.0–0.6	GSiR	N	5–10
Atlantic tomcod	≥ 10	0.0–4.0	SaG	N	0–4
Copper redhorse	moderate	1.5–2.0	SiR	US	≥ 18

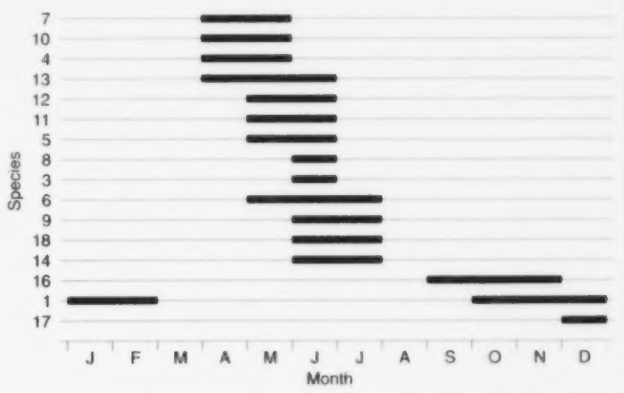
*** SUBSTRATE**

C	Clay
S	Silt
Sa	Sand
G	Gravel
Si	Shingle
R	Rock

**** VEGETATION**

N	No vegetation
NC	None or cleared
HESA	Herbaceous emergent semi-aquatic plants
SHL	Submerged herbaceous land plants
SHG	Submerged herbaceous graminoid land plants
US	Unspecified vegetation
SH	Submerged herbaceous plants

SPAWNING PERIOD



Source: • Gilles Shooner et ass. 1990. *Caractérisation des habitats recherchés pour la fraie des principales espèces de poisson du fleuve Saint-Laurent*. For Fisheries and Oceans, and Environment Canada.
• Gilles Shooner et ass. 1991. *Localisation des sites de reproduction des principales espèces de poisson du fleuve Saint-Laurent (Cornwall-Montmagny)*. Maps. For Fisheries and Oceans, and Environment Canada.

Environment Canada Environnement Canada

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March 1997

The St. Lawrence River – Beaches (1990–95)

BEACH ENVIRONMENT PROGRAM OF THE MINISTÈRE DE L'ENVIRONNEMENT ET DE LA FAUNE

Program to monitor the bacteriological quality of swimming water at certain sites, in accordance with provincial Labour Ministry standards for:

- Adequacy of supervision
- Availability of safety equipment
- Installation of look-out station
- Demarcation of boundaries of supervised area
- Means of emergency communication
- Posted notices indicating beach boundaries and hours of supervision.

HISTORY OF BEACHES AUTHORIZED IN 1995

Name of beach	1990	1991	1992	1993	1994	1995
1. Baie du Village Park (Saint-Anicet)	■	■	■	■	■	■
2. Camp Mont-Immaculée Beach (Saint-Anicet)	■	■	■	■	■	■
3. Municipal beach (Saint-Zotique)	■	■	■	■	■	■
4. Camp La Villa Notre-Dame de Fatima (Vaudreuil)	■	■	■	■	■	■
5. Sainte-Madeleine-de-Rigaud Beach (Sainte-Madeleine-de-Rigaud)	■	■	■	■	■	■
6. Oka Park Beach (Oka)	■	■	■	■	■	■
7. Cap-Saint-Jacques No. 1 (MUC, Pierrefonds)	■	■	■	■	■	■
8. Cap-Saint-Jacques No. 2 (MUC, Pierrefonds)	■	■	■	■	■	■
9. Bois de l'Île Bizard regional park beach (MUC, Saint-Raphaël-de-l'Île-Bizard)			■	■	■	■
10. Saguenay Sailing Club (Shipshaw)	■	■	■	■	■	■
11. Dam-en-Terre Campground (Alma)	■	■	■	■	■	■
12. Colonie Notre-Dame (Alma)	■	■	■	■	■	■
13. Cartier Beach (Sainte-Anne-des-Monts)				■	■	■
14. Haldimand Beach (Gaspé)	■	■	■	■	■	■
15. Beau-Bassin Beach (Bonaventure)	■	■	■	■	■	■
16. Municipal beach (Maria)						■

■ Year of operation

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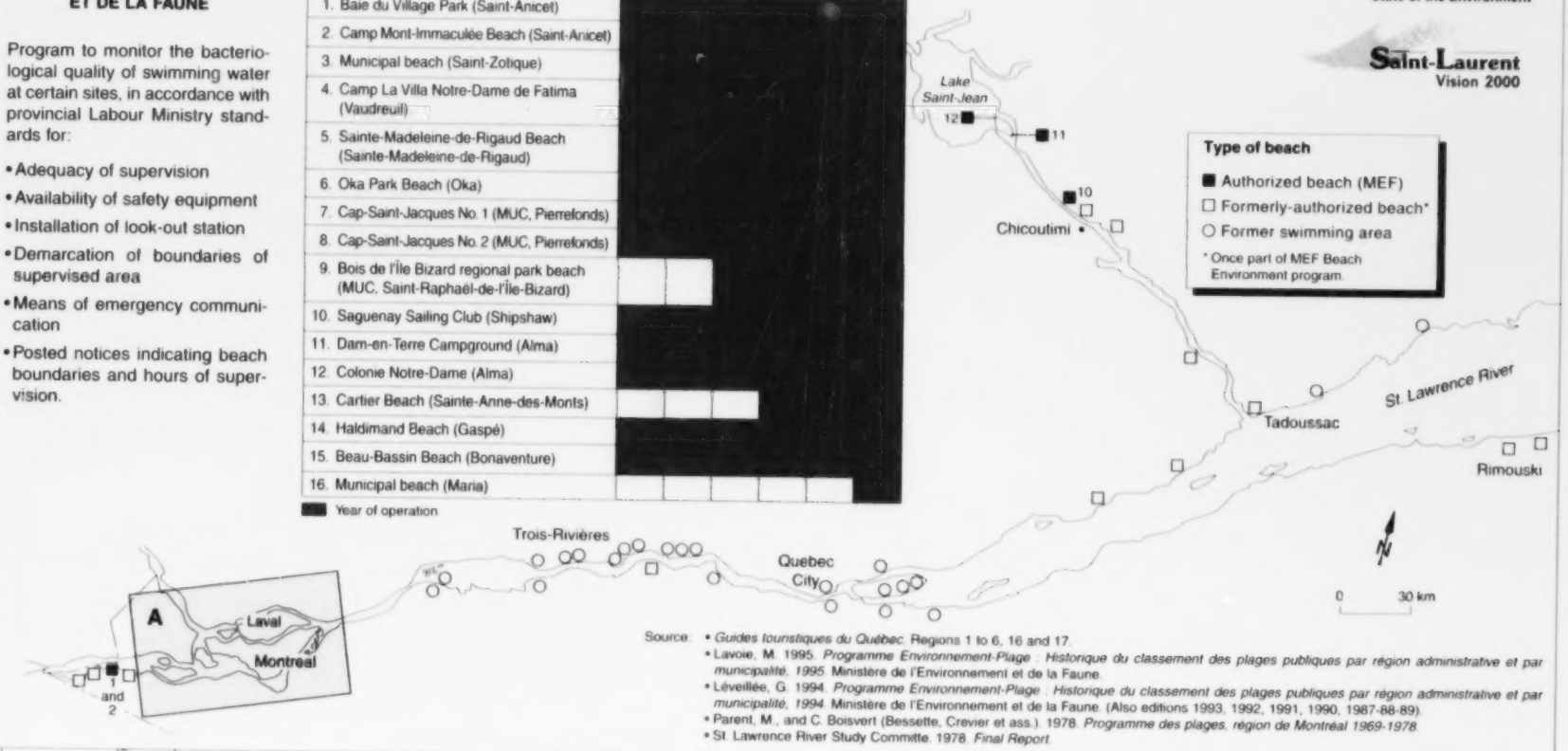

Source:
- *Guides touristiques du Québec*. Regions 1 to 6, 16 and 17.
- Lavoie, M. 1995. *Programme Environnement-Plage : Historique du classement des plages publiques par région administrative et par municipalité, 1995*. Ministère de l'Environnement et de la Faune.
- Léveillée, G. 1994. *Programme Environnement-Plage : Historique du classement des plages publiques par région administrative et par municipalité, 1994*. Ministère de l'Environnement et de la Faune. (Also editions 1993, 1992, 1991, 1990, 1987-88-89).
- Parent, M., and C. Boisvert (Bessette, Crevier et ass.). 1978. *Programme des plages, région de Montréal 1969-1978*.
- St. Lawrence River Study Committe. 1978. *Final Report*.

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INFO-FLASH 23

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2. Camp Mont-Immaculée Beach (Saint-Anicet)	■	■	■	■	■	■
3. Municipal beach (Saint-Zotique)	■	■	■	■	■	■
4. Camp La Villa Notre-Dame de Fatima (Vaudreuil)	■	■	■	■	■	■
5. Sainte-Madeleine-de-Rigaud Beach (Sainte-Madeleine-de-Rigaud)	■	■	■	■	■	■
6. Oka Park Beach (Oka)	■	■	■	■	■	■
7. Cap-Saint-Jacques No. 1 (MUC, Pierrefonds)	■	■	■	■	■	■
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10. Saguenay Sailing Club (Shipshaw)	■	■	■	■	■	■
11. Dam-en-Terre Campground (Alma)	■	■	■	■	■	■
12. Colonie Notre-Dame (Alma)	■	■	■	■	■	■
13. Cartier Beach (Sainte-Anne-des-Monts)				■	■	■
14. Haldimand Beach (Gaspé)	■	■	■	■	■	■
15. Beau-Bassin Beach (Bonaventure)	■	■	■	■	■	■
16. Municipal beach (Maria)						■

■ Year of operation

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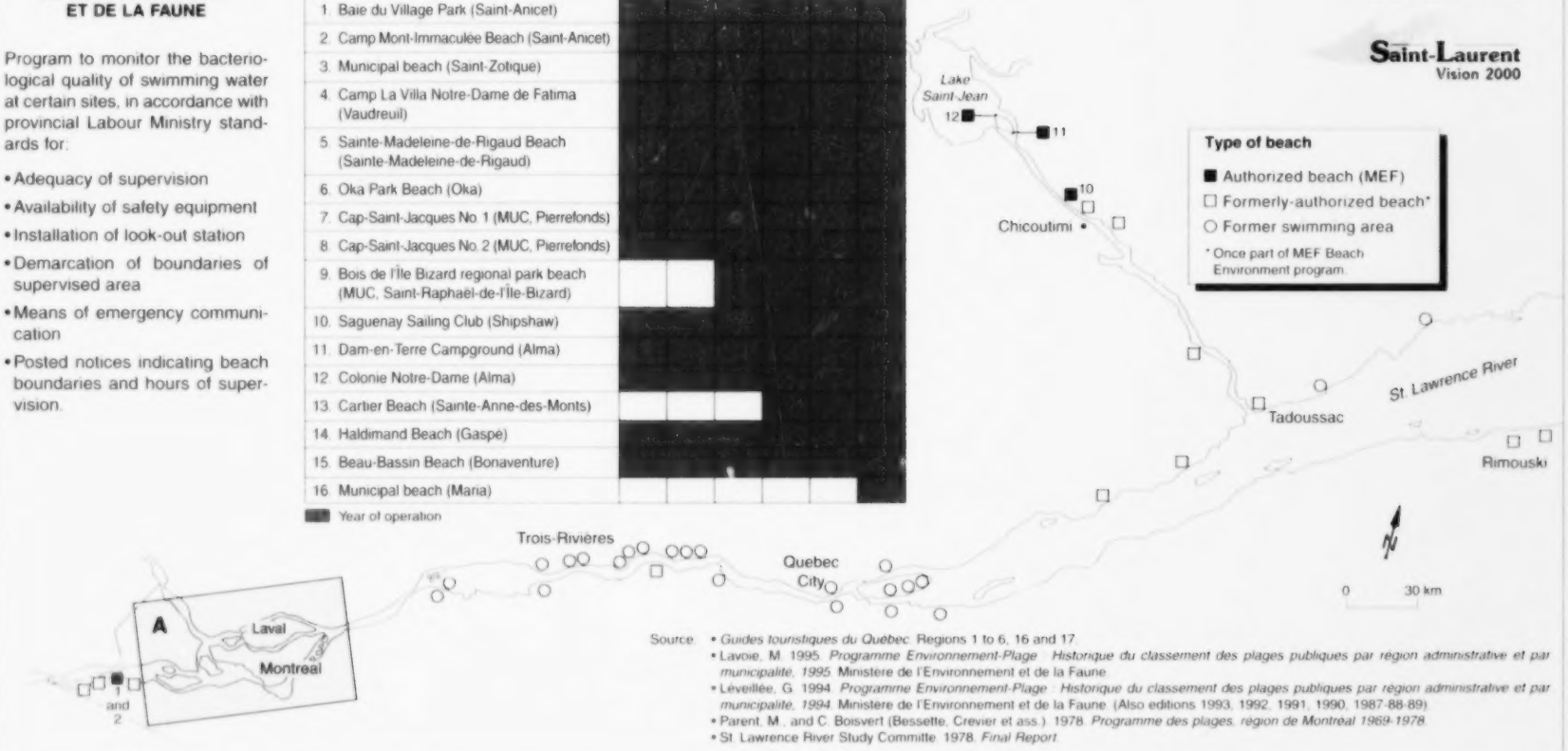

Source:
- *Guides touristiques du Québec*. Regions 1 to 6, 16 and 17.
- Lavoie, M. 1995. *Programme Environnement-Plage : Historique du classement des plages publiques par région administrative et par municipalité, 1995*. Ministère de l'Environnement et de la Faune.
- Léveillée, G. 1994. *Programme Environnement-Plage : Historique du classement des plages publiques par région administrative et par municipalité, 1994*. Ministère de l'Environnement et de la Faune. (Also editions 1993, 1992, 1991, 1990, 1987-88-89)
- Parent, M., and C. Boisvert (Bessette, Crevier et ass.). 1978. *Programme des plages, région de Montréal 1969-1978*.
- St. Lawrence River Study Committe. 1978. *Final Report*.

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INFO-FLASH 24

The St. Lawrence River – Cultivated Land (1991)

RCM	RCM surface area (ha)	Cultivated land* (ha)	Cultivated land/ RCM area (%)
SOUTH SHORE			
Le Haut-Saint-Laurent	116 998	43 252	40
Beauharnois-Salaberry	46 171	28 780	62
Roussillon	42 153	17 723	42
Champlain	16 284	925	6
Lajemmerais	41 434	15 387	37
Le Bas-Richelieu	59 340	27 099	46
Nicolet-Yamaska	100 143	48 369	49
Bécancour	113 563	25 927	23
Lotbinière	164 727	33 586	20
Les Chutes-de-la-Chaudière	41 864	4 643	11
Desjardins	25 377	7 812	30
Bellechasse	162 947	33 067	20
Montmagny	167 825	14 320	9
L'Islet	209 162	17 550	8
Kamouraska	192 932	28 146	15
Rivière-du-Loup	126 938	23 304	18
Les Basques	123 171	14 594	12
Rimouski-Neigette	257 516	18 235	7
La Mitis	229 365	20 422	9
Matane	331 166	12 196	4
Denis-Riverin	512 621	1 336	< 1
La Côte-de-Gaspé	414 326	408	< 1
Pabok	307 535	844	< 1
Bonaventure	432 951	6 651	2
Avignon	364 543	4 276	1
Les Îles-de-la-Madeleine	20 235	105	< 1
SOUTH SHORE total	**4 621 287**	**489 192**	**11**

RCM	RCM surface area (ha)	Cultivated land* (ha)	Cultivated land/ RCM area (%)
NORTH SHORE			
Vaudreuil-Soulanges	85 222	39 935	47
Laval	24 540	3 361	14
Deux-Montagnes	24 131	9 395	40
Thérèse-De Blainville	20 442	4 806	24
Les Moulins	26 361	5 577	21
L'Assomption	25 318	9 567	38
D'Autray	118 806	37 077	31
Maskinongé	200 213	29 516	15
Francheville	112 786	24 237	21
Portneuf	392 439	26 008	7
L'Île-d'Orléans	19 491	8 589	44
La Côte-de-Beaupré	498 514	2 693	1
Charlevoix	375 663	4 108	1
Charlevoix-Est	237 513	2 896	1
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Manicouagan	3 178 030	504	< 1
NORTH SHORE total	**16 115 909**	**223 024**	**1**

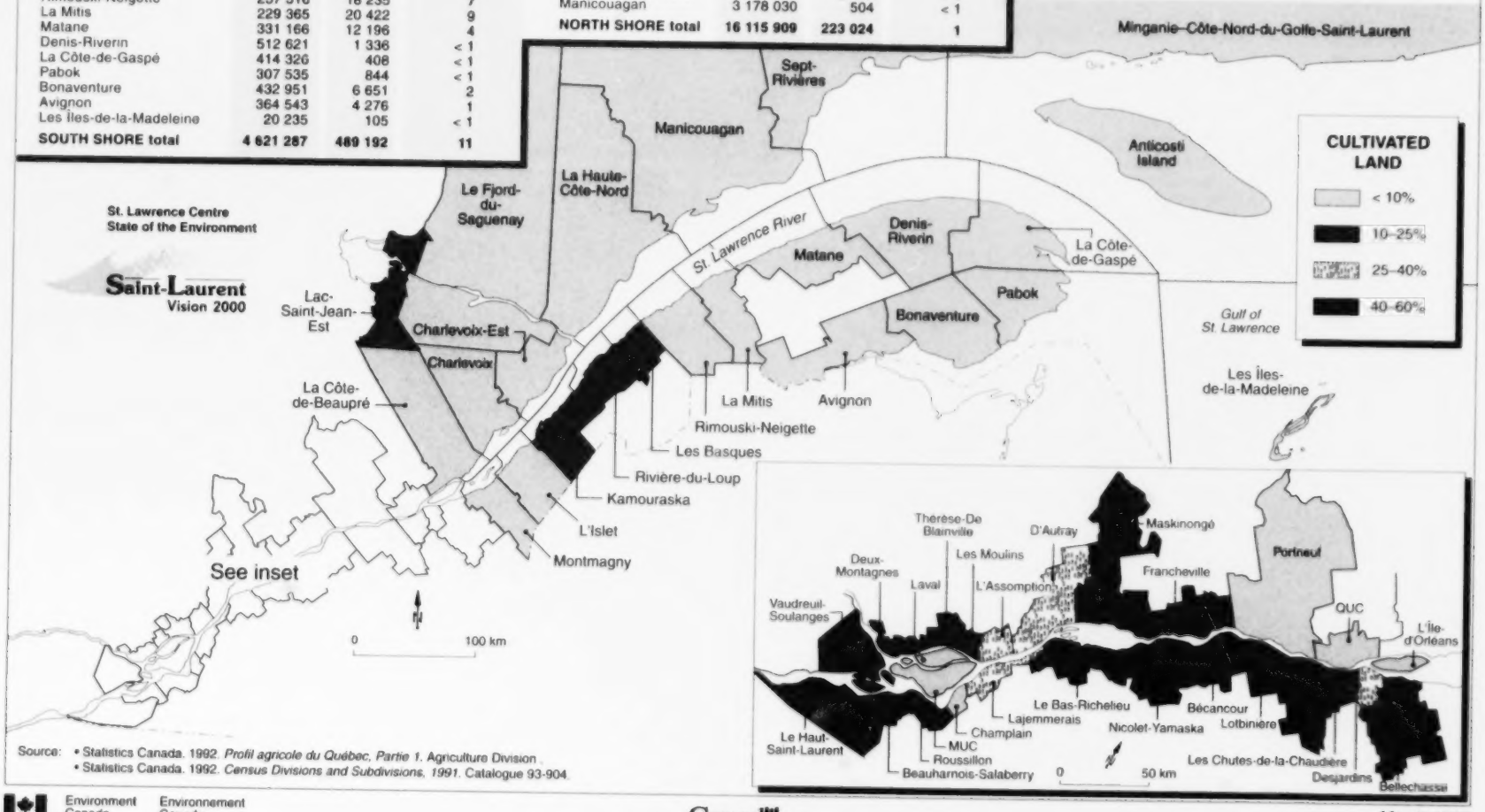
RCM	RCM surface area (ha)	Cultivated land* (ha)	Cultivated land/ RCM area (%)
MUC	49 357	458	1
QUC	54 345	4 207	8
TOTAL	**20 737 196**	**712 216**	**3**
QUEBEC TOTAL	**135 781 173**	**1 638 453**	**1**

* Cultivated land: Total surface areas given over to field crops, fruit, vegetables, sod and tree nursery products.

RCM: Regional County Municipality.

Because Sept-Rivières, Minganie and Côte-Nord-du-Golfe-Saint-Laurent RCMs are grouped together in a much larger territory that includes all of northern Quebec, they were not considered here.

The cultivated lands of riverside RCMs represented 43% of all cultivated lands in Quebec in 1991.



Source: • Statistics Canada. 1992. *Profil agricole du Québec, Partie 1*. Agriculture Division.
• Statistics Canada. 1992. *Census Divisions and Subdivisions, 1991*. Catalogue 93-904.

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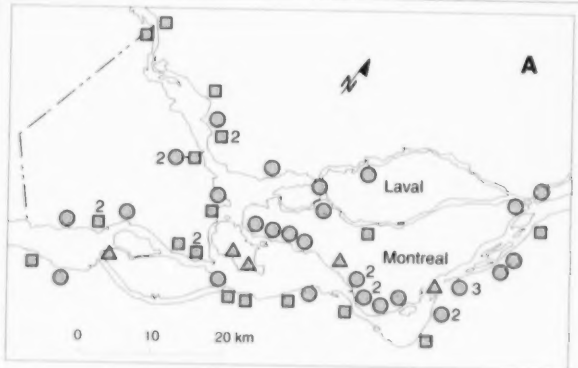
March 1997

INFO-FLASH 25

The St. Lawrence River – Pleasure Boating



CENSUS OF SMALL PLEASURE CRAFT*, BY TYPE AND SECTOR, IN 1988

Type of craft	Sector A	B	C	Total
Dinghy	3 586	510	662	4 758
Keelboat	2 262	695	162	3 119
Multi-hull	421	57	172	490
Conventional open**	17 082	1 318	4 723	23 123
Conventional closed**	8 084	585	595	9 264
Other	1 303	12	25	1 340
Total	32 738	3 177	6 179	42 094

* Any craft with a registered tonnage not exceeding 15 tonnes or any pleasure craft with a registered tonnage not exceeding 20 tonnes.

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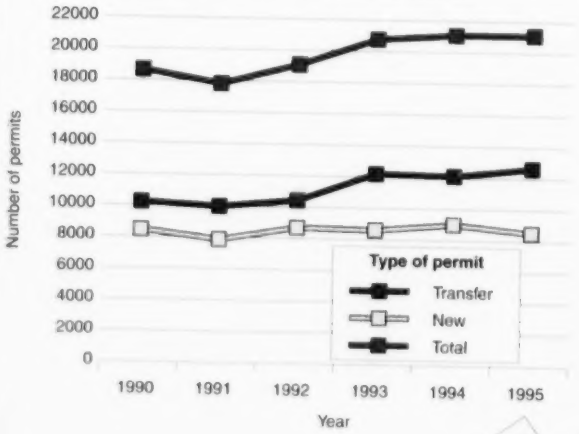
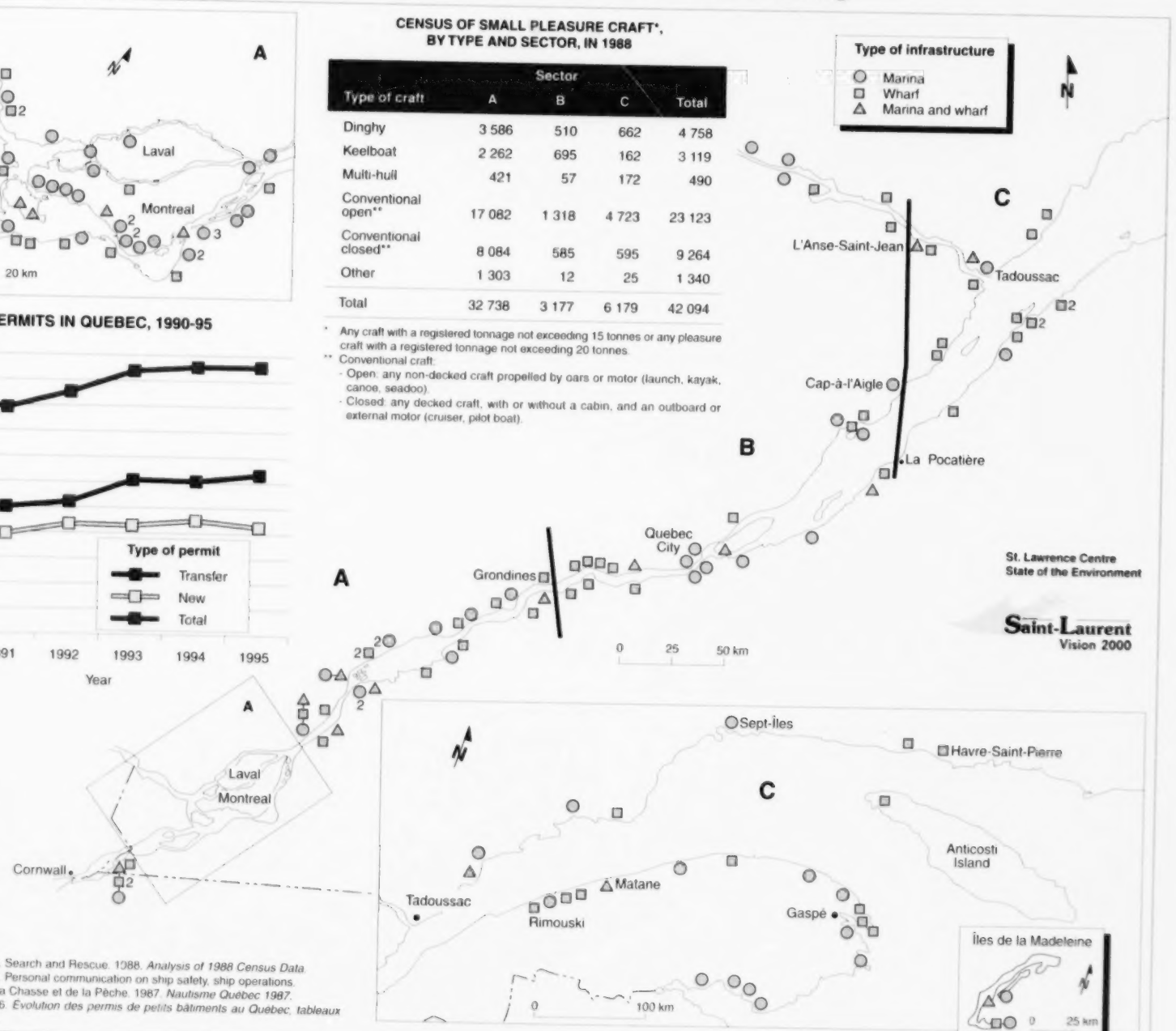
BOATING PERMITS IN QUEBEC, 1990-95





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Source:
- Canadian Coast Guard. Search and Rescue. 1988. *Analysis of 1988 Census Data.*
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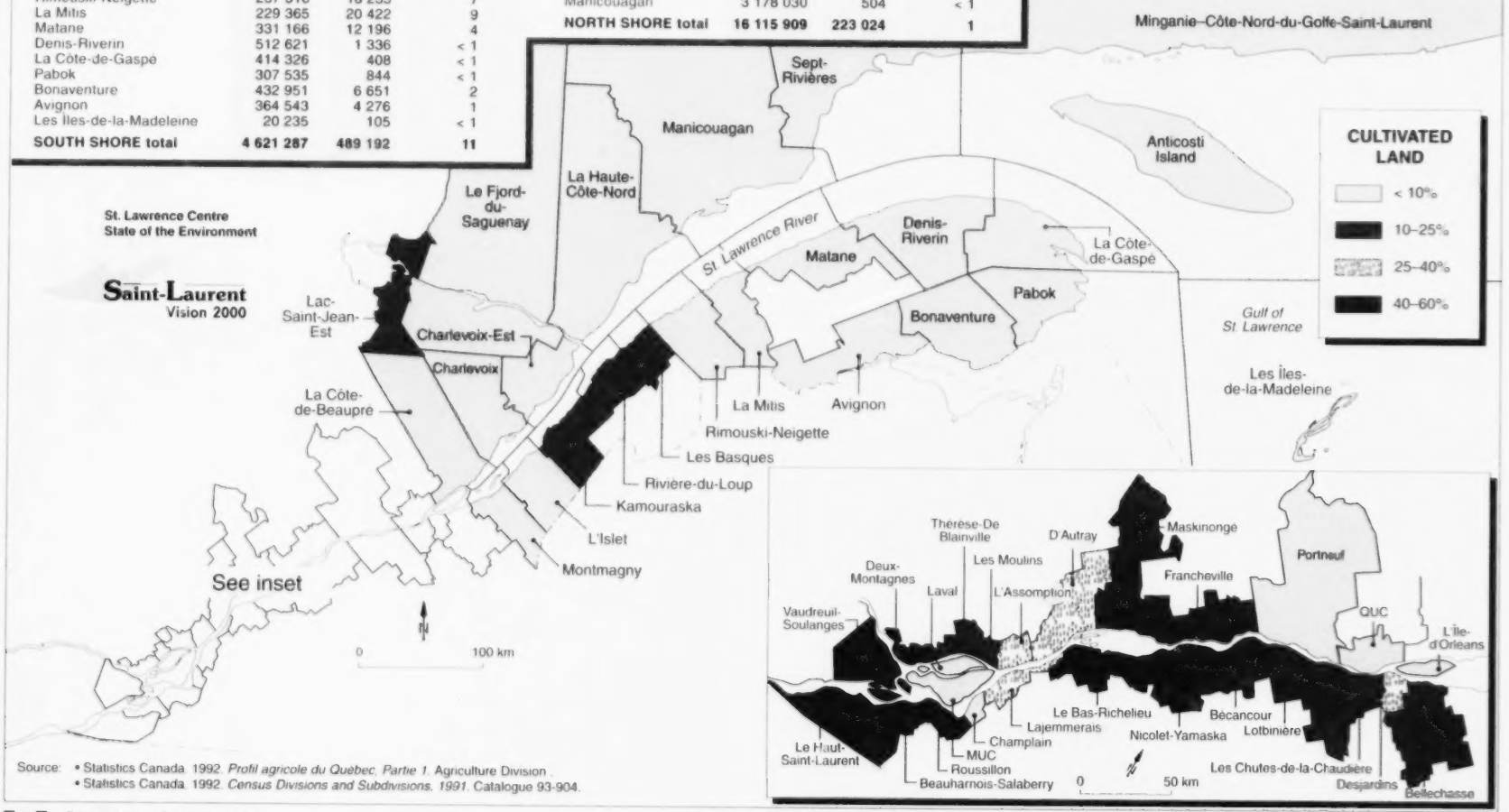

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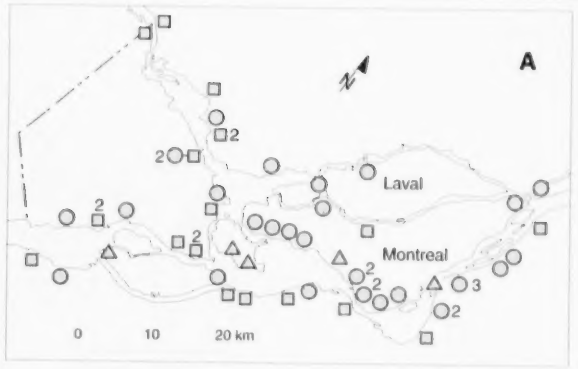
The St. Lawrence River – Pleasure Boating



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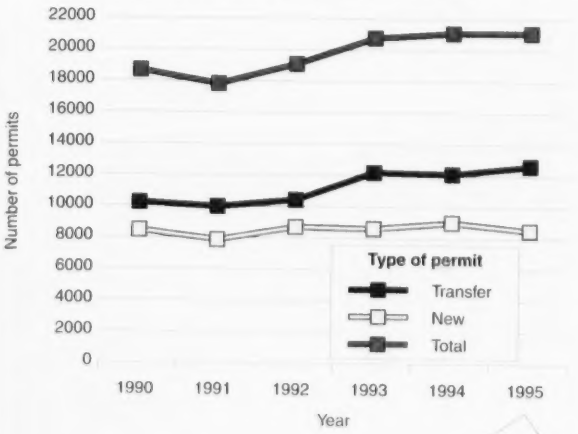

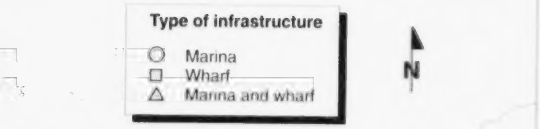

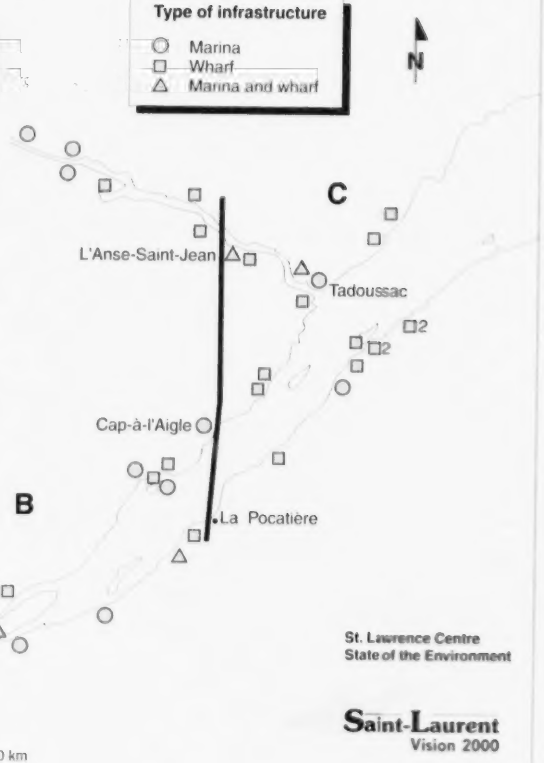

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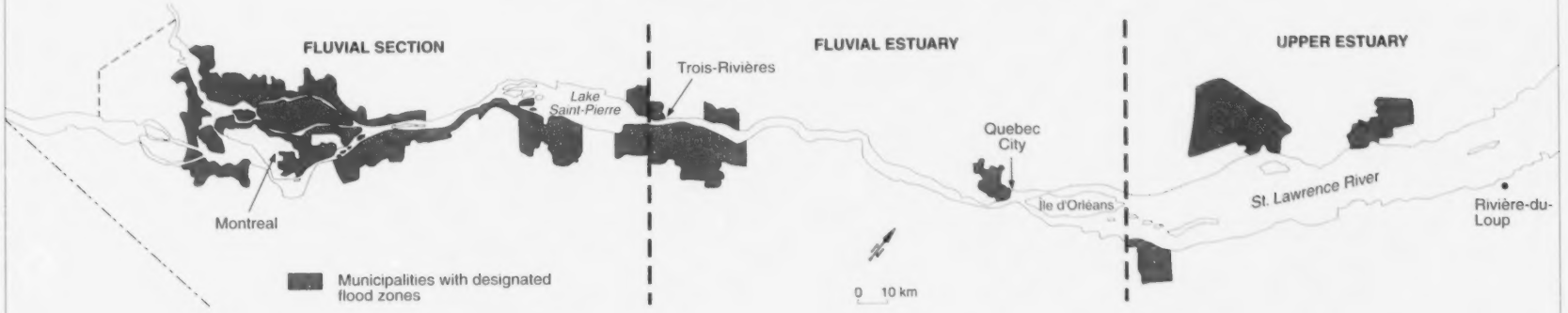
The St. Lawrence River – Riverside Municipalities and Flood Zones

RIVERSIDE MUNICIPALITIES WITH DESIGNATED FLOOD ZONES



AGREEMENT RESPECTING THE MAPPING AND PROTECTION OF FLOOD PLAINS AND THE SUSTAINABLE DEVELOPMENT OF WATER RESOURCES

Period

- 1978 to 1997 to complete mapping.
- 1987 to 2002 to apply intervention policy.

Objective

- To map flood-prone areas.
- To establish a joint intervention policy aimed at reducing damage in designated flood zones and in provisional flood zones.
- To conduct special studies on the sustainable development of the water resource.

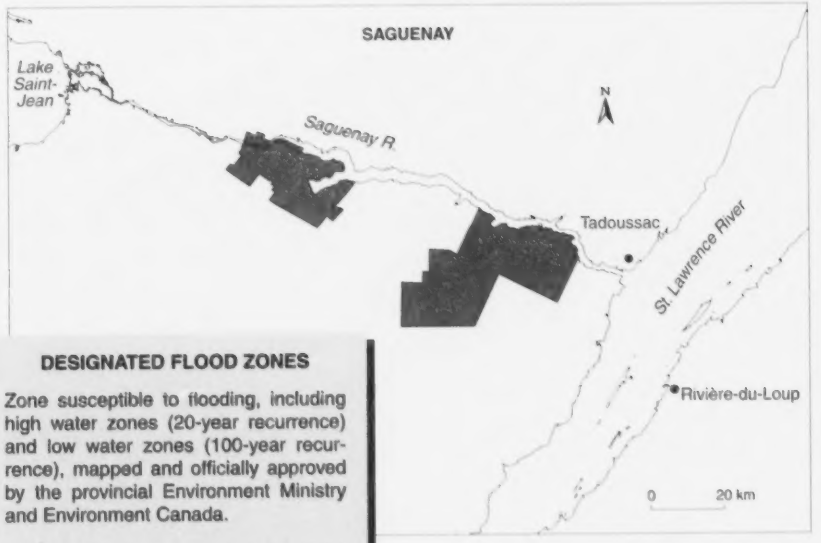
Intervention policy

Unless otherwise decided, in both designated and provisional flood zones:

- No federal or provincial installations shall be built.
- No financial assistance shall be granted for existing or planned installations.
- In the event of flooding, no indemnity shall be paid for damage to or loss of property or installations constructed after establishment of the flood zone.
- The federal and provincial governments shall encourage authorities under their jurisdiction to prohibit the construction of installations, to impose restrictions or to impose indemnity measures against flooding.

Note: There are exceptions to and departures from this intervention policy.

Source: *Convention entre le gouvernement du Canada et le gouvernement du Québec relativement à la cartographie et à la protection des plaines d'inondation et au développement durable des ressources en eau.* 1994.



DESIGNATED FLOOD ZONES

Zone susceptible to flooding, including high water zones (20-year recurrence) and low water zones (100-year recurrence), mapped and officially approved by the provincial Environment Ministry and Environment Canada.

The official mapping of flood-prone zones (or designated flood zones) will be completed on March 31, 1997, for 75 riverside municipalities. Of these municipalities, 57 are in the Fluvial Section, 5 in the Fluvial Estuary, 6 in the Upper Estuary, 4 along the Saguenay River, 2 in the Lower Estuary (not shown), and 1 in the Gulf (not shown).

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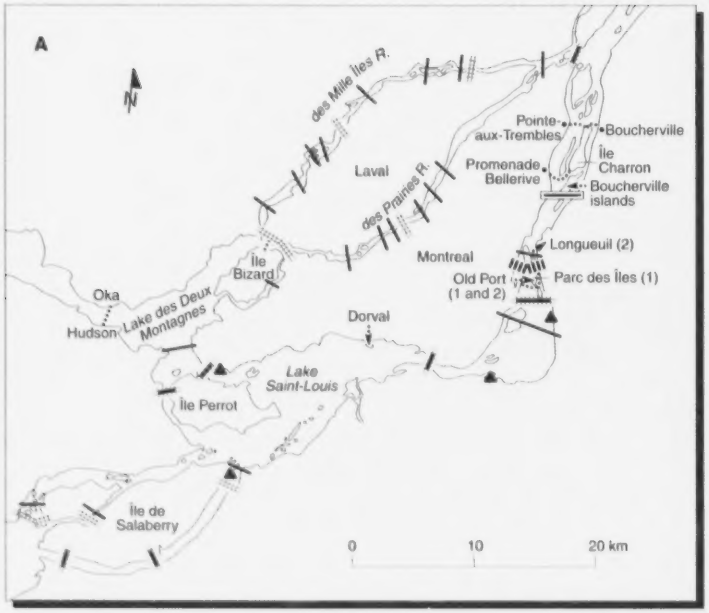
March 1997

The St. Lawrence River – Bridges, Ferries and Locks



BRIDGES	36
des Mille Îles River	7
des Prairies River	9
Lake des Deux Montagnes	3
Beauharnois Canal	3
St. Lawrence River (including one bridge-tunnel and one subway tunnel)	14
FERRIES	**26**
• Seasonal or year-round	
• Daily or weekly	
• Carry: - cars and pedestrians - pedestrians and cyclists only	
RAILWAY CROSSINGS	**15**
LOCKS	**4**

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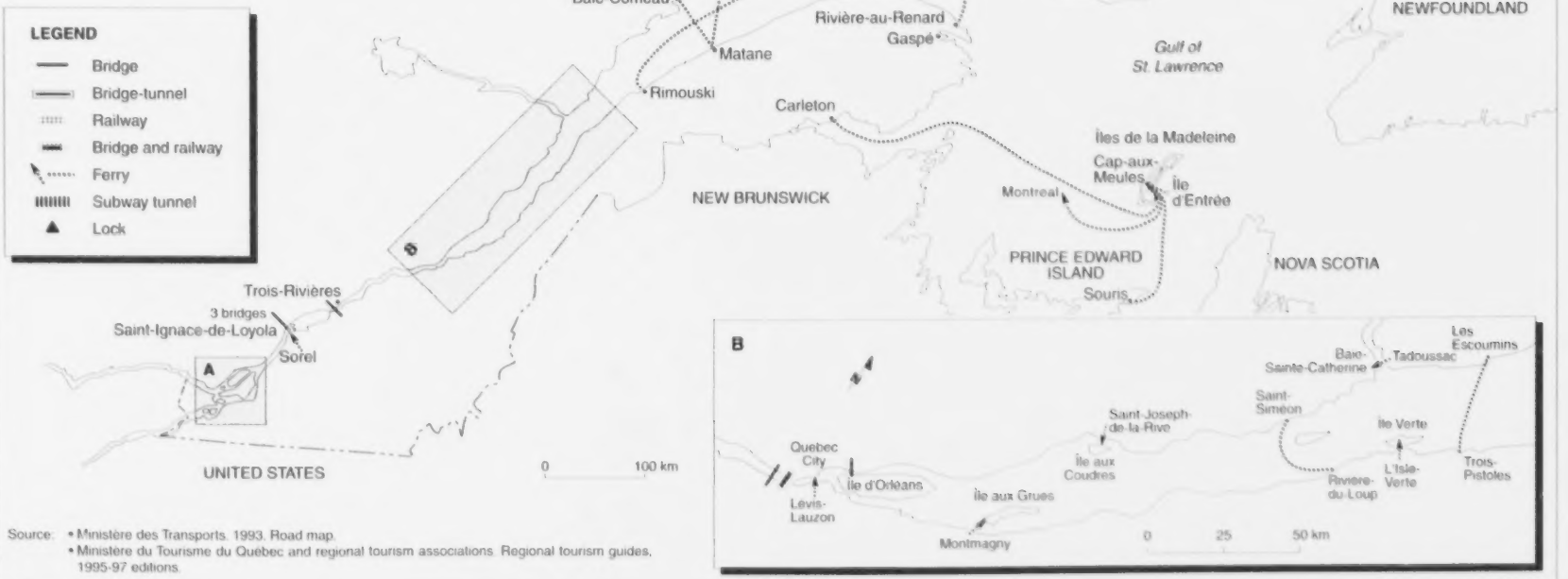

Source: • Ministère des Transports. 1993. Road map.
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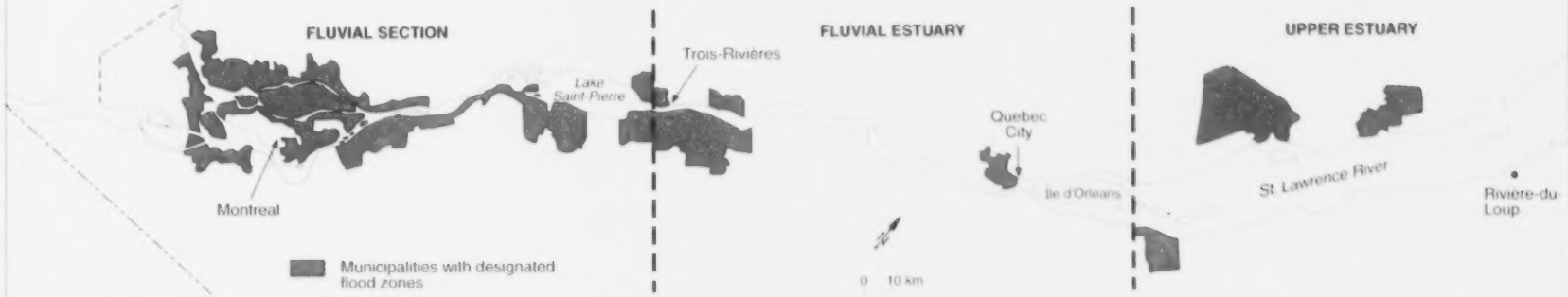
The St. Lawrence River – Riverside Municipalities and Flood Zones

RIVERSIDE MUNICIPALITIES WITH DESIGNATED FLOOD ZONES



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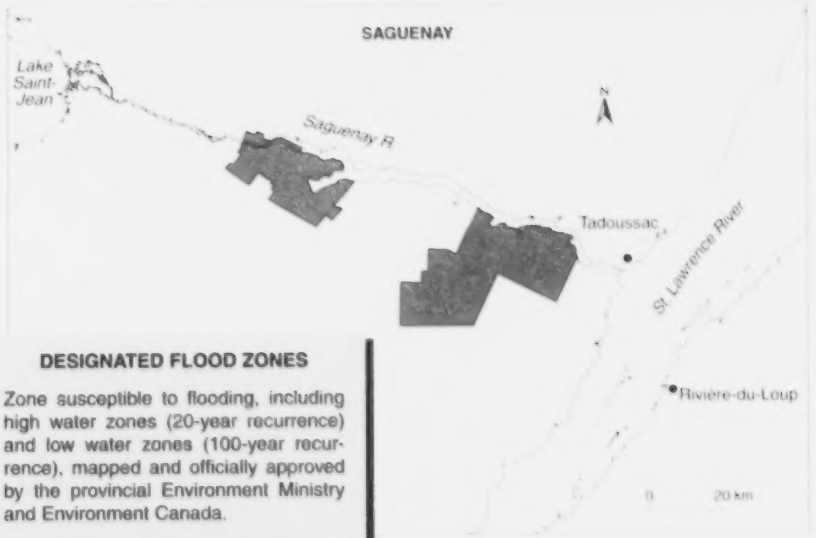

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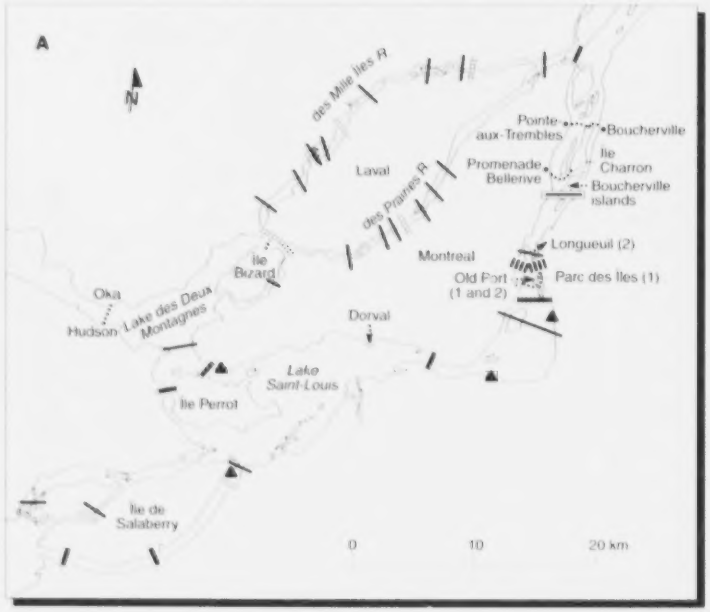
The St. Lawrence River – Bridges, Ferries and Locks



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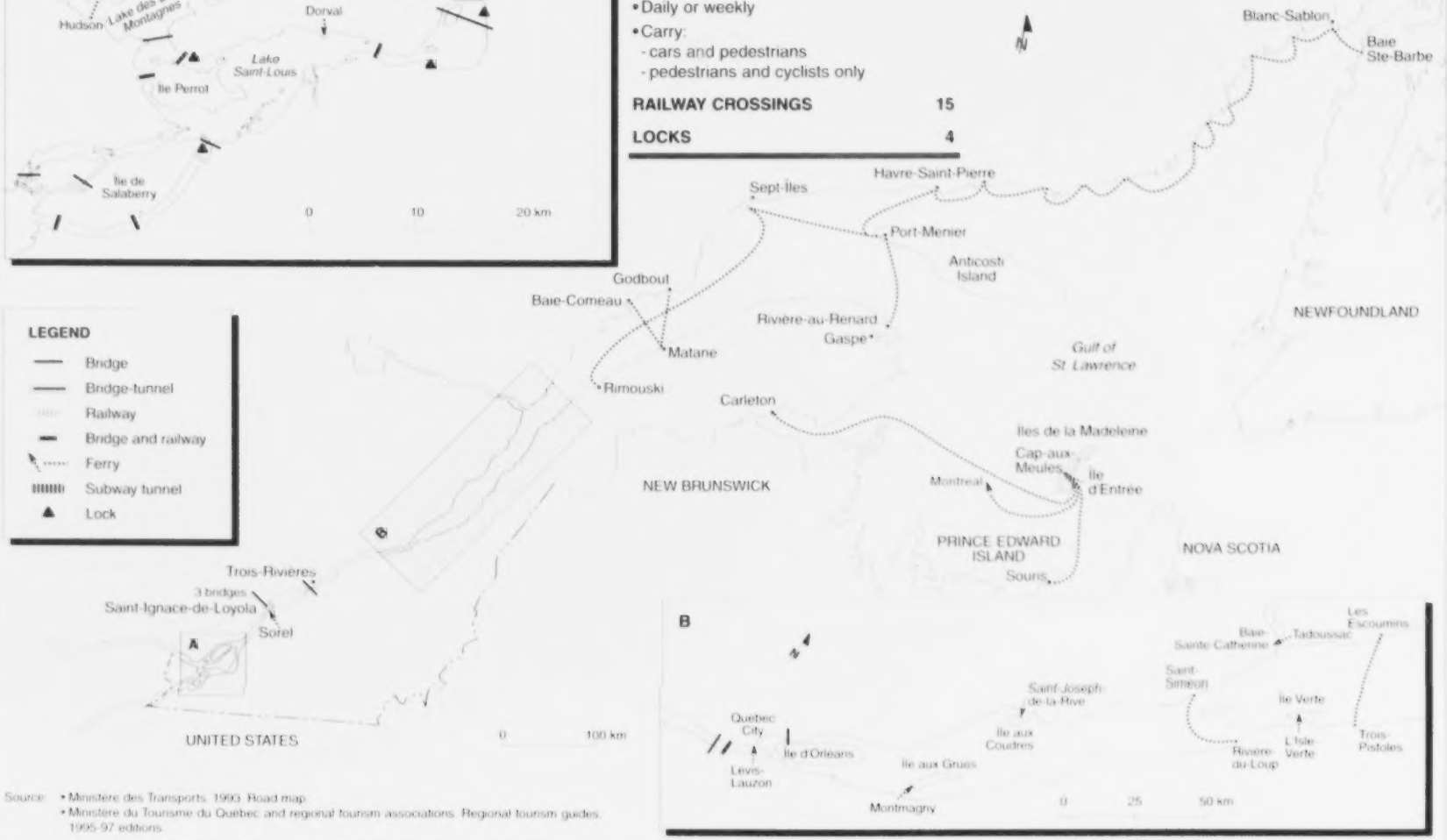

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The St. Lawrence River – Whale Watching from 1984 to 1993

QUEBEC'S WHALE-WATCHING INDUSTRY came into being in 1983. This activity takes place from mid-May through late October, with peak traffic from mid-July to mid-August. In 1988, Quebecers made up 52% of whale watchers and Europeans 24%, with other Canadians and American tourists making up the remaining 24%.

SPECIES SIGHTED

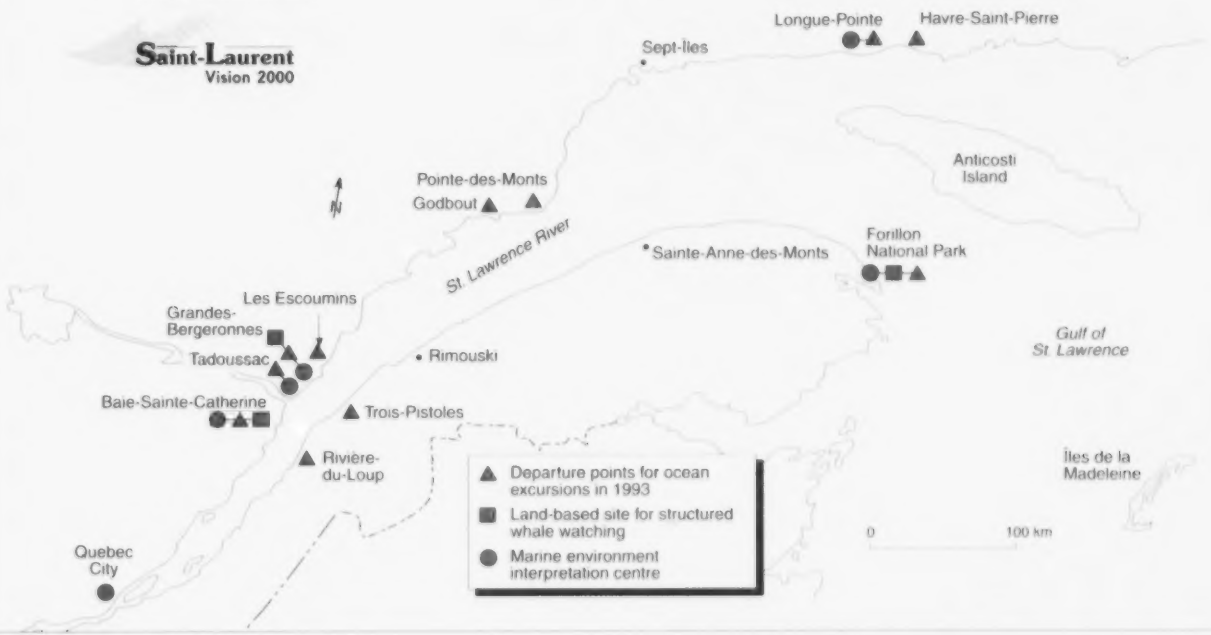
Six whale species frequent the St. Lawrence Gulf and Estuary on a regular basis: the Beluga, Minke, Fin, Blue, and Humpback whale, and the Harbour porpoise. The Minke, Fin, Blue and Humpback whales are the most sought after by whale watchers at sea. Beluga whales are not included in this activity due to the particularly fragile status of the population.

WHALE-WATCHING ACTIVITIES IN THE UPPER ESTUARY FROM 1984 TO 1993

	1984	1988	1993
Number of companies offering whale-watching excursions	7	11	20
Number of active vessels	11	17	34
Number of home ports	4	6	6
Annual number of excursions	913	2 052	4 960
Number of passengers on whale-watching excursions	19 740	77 800	200 000
Number of visitors to land-based sites	7 670	33 000	67 200
a) Pointe-Noire Interpretation and Observation Centre (Baie-Sainte-Catherine)	(a)	(a, b, c)	(a, b, c)
b) Cap-de-Bon-Désir Interpretation and Observation Centre (Bergeronnes)			
c) GREMM Marine Environment Interpretation Centre (Tadoussac)			
Number of jobs linked directly to whale watching	34	125	ND
Total gross revenue of whale-watching industry	$1 603 300	$8 191 500	ND

St. Lawrence Centre
State of the Environment

Saint-Laurent
Vision 2000



WHALE WATCHING AT SEA AND DISTURBANCE OF WHALES

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REGULATION AND CODE OF ETHICS

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Improved knowledge of marine mammals and controls on whale-watching activities at sea will allow us to protect the whale populations that depend on St. Lawrence resources, while ensuring the survival of an industry upon which an increasing number of people in the region depend.

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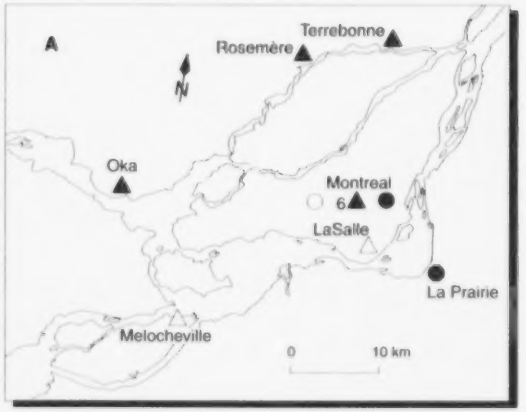
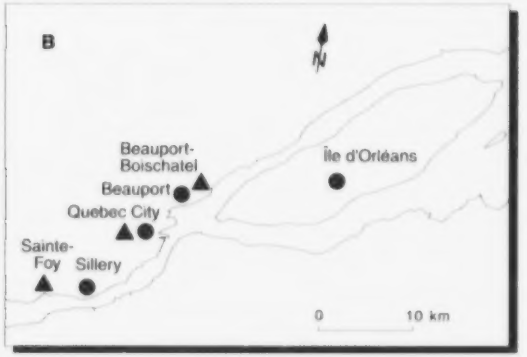
The St. Lawrence River – Classified Provincial Sites and Areas (1996)

THE CLASSIFICATION OF CULTURAL PROPERTY remains the most important measure of protection provided under the Quebec *Cultural Property Act*. The Act applies to property with an exceptional heritage value and a symbolic value to the people of Quebec.





- Historic area
- Natural area
- Historic site
- Archaeological site

Note: The number preceding the symbol indicates the number of corresponding elements.

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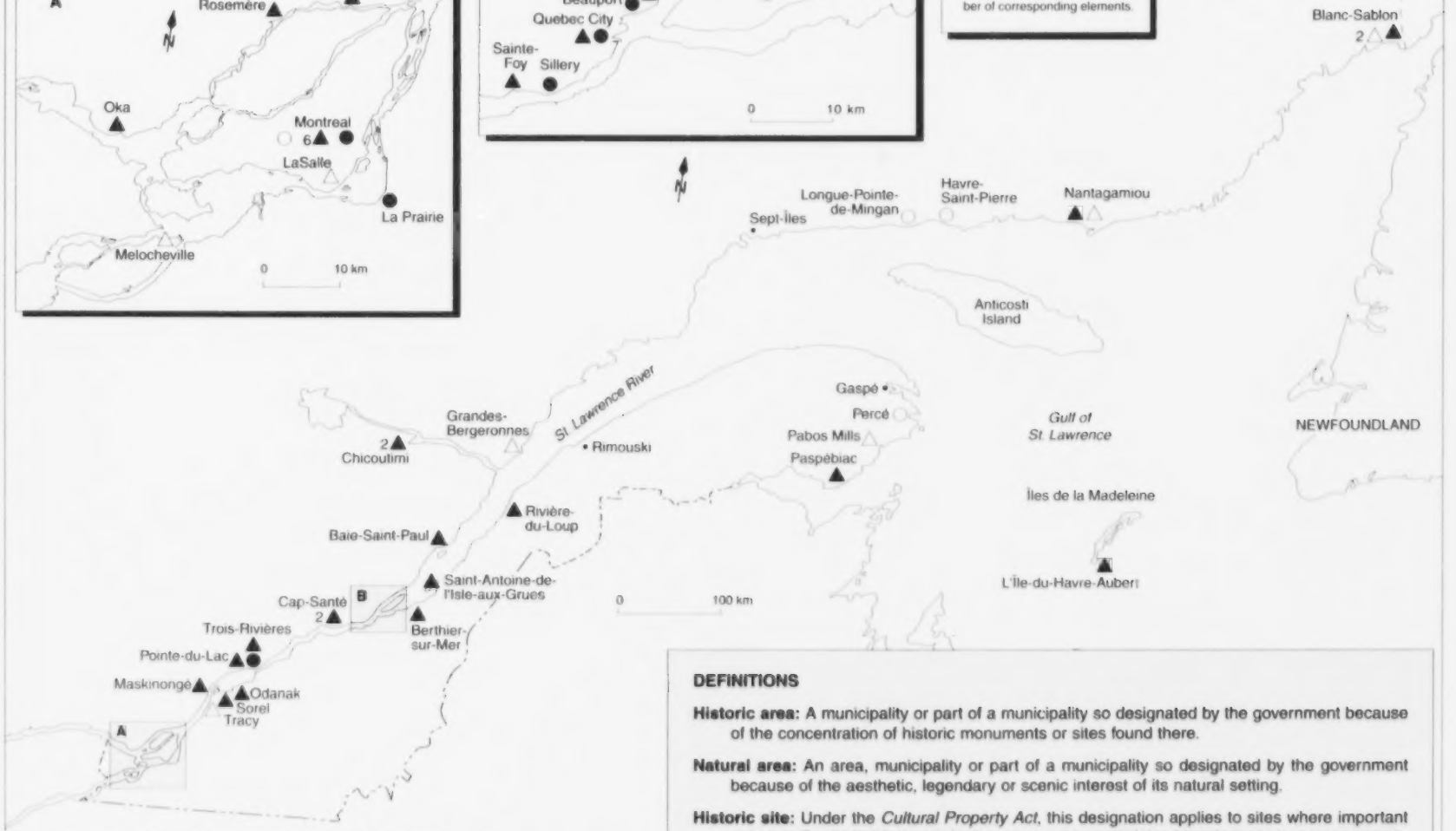

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The St. Lawrence River – Whale Watching from 1984 to 1993

QUEBEC'S WHALE-WATCHING INDUSTRY came into being in 1983. This activity takes place from mid-May through late October, with peak traffic from mid-July to mid-August. In 1988, Quebecers made up 52% of whale watchers and Europeans 24%, with other Canadians and American tourists making up the remaining 24%.

SPECIES SIGHTED

Six whale species frequent the St. Lawrence Gulf and Estuary on a regular basis: the Beluga, Minke, Fin, Blue, and Humpback whale, and the Harbour porpoise. The Minke, Fin, Blue and Humpback whales are the most sought after by whale watchers at sea. Beluga whales are not included in this activity due to the particularly fragile status of the population.

WHALE-WATCHING ACTIVITIES IN THE UPPER ESTUARY FROM 1984 TO 1993

	1984	1988	1993
Number of companies offering whale-watching excursions	7	11	20
Number of active vessels	11	17	34
Number of home ports	4	6	6
Annual number of excursions	913	2 052	4 960
Number of passengers on whale-watching excursions	19 740	77 800	200 000
Number of visitors to land-based sites	7 670	33 000	67 200
a) Pointe-Noire Interpretation and Observation Centre (Baie-Sainte-Catherine)	(a)	(a, b, c)	(a, b, c)
b) Cap-de-Bon-Désir Interpretation and Observation Centre (Bergeronnes)			
c) GREMM Marine Environment Interpretation Centre (Tadoussac)			
Number of jobs linked directly to whale watching	34	125	ND
Total gross revenue of whale-watching industry	$1 603 300	$8 191 500	ND

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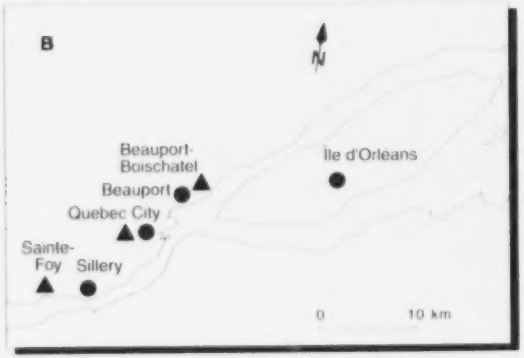

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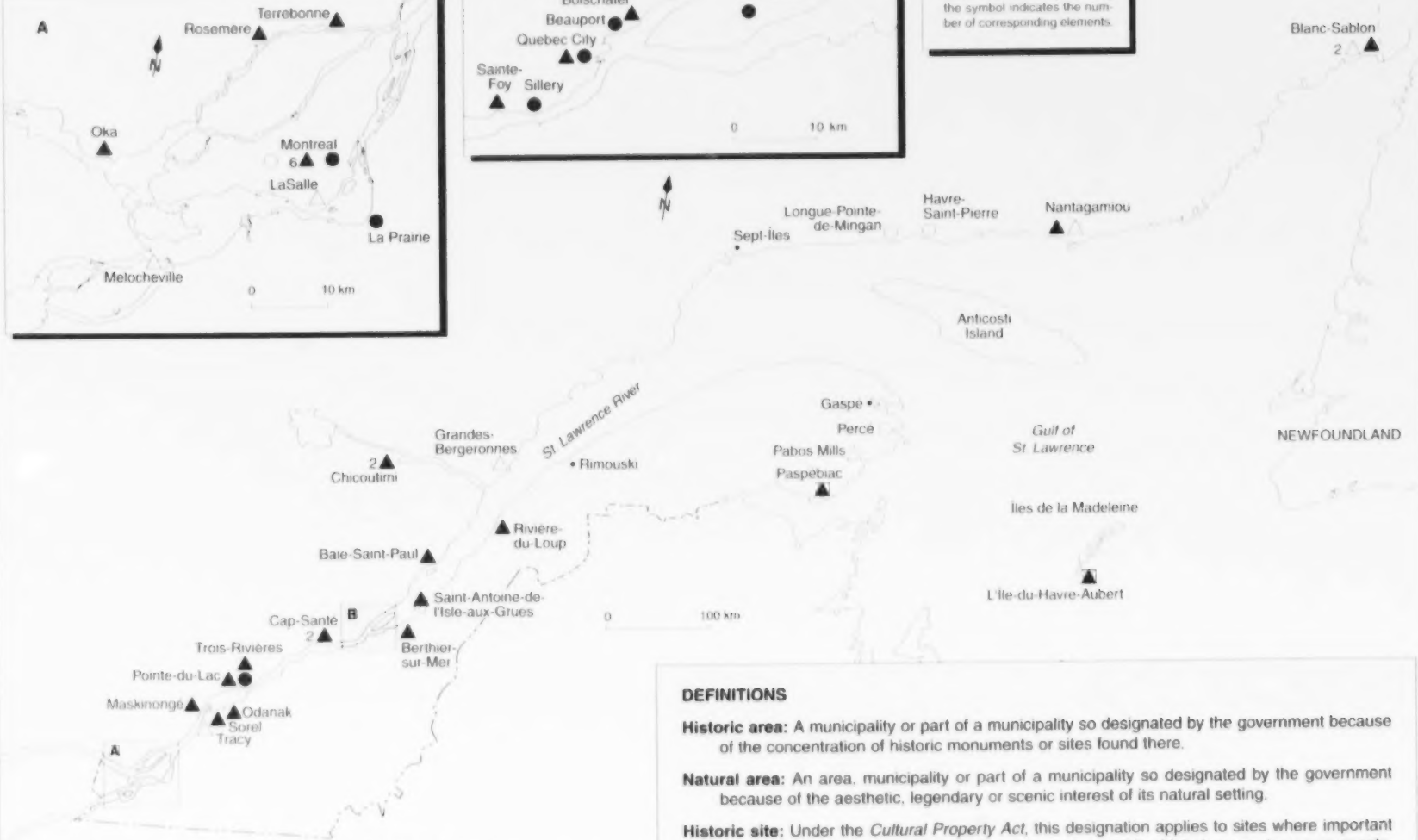

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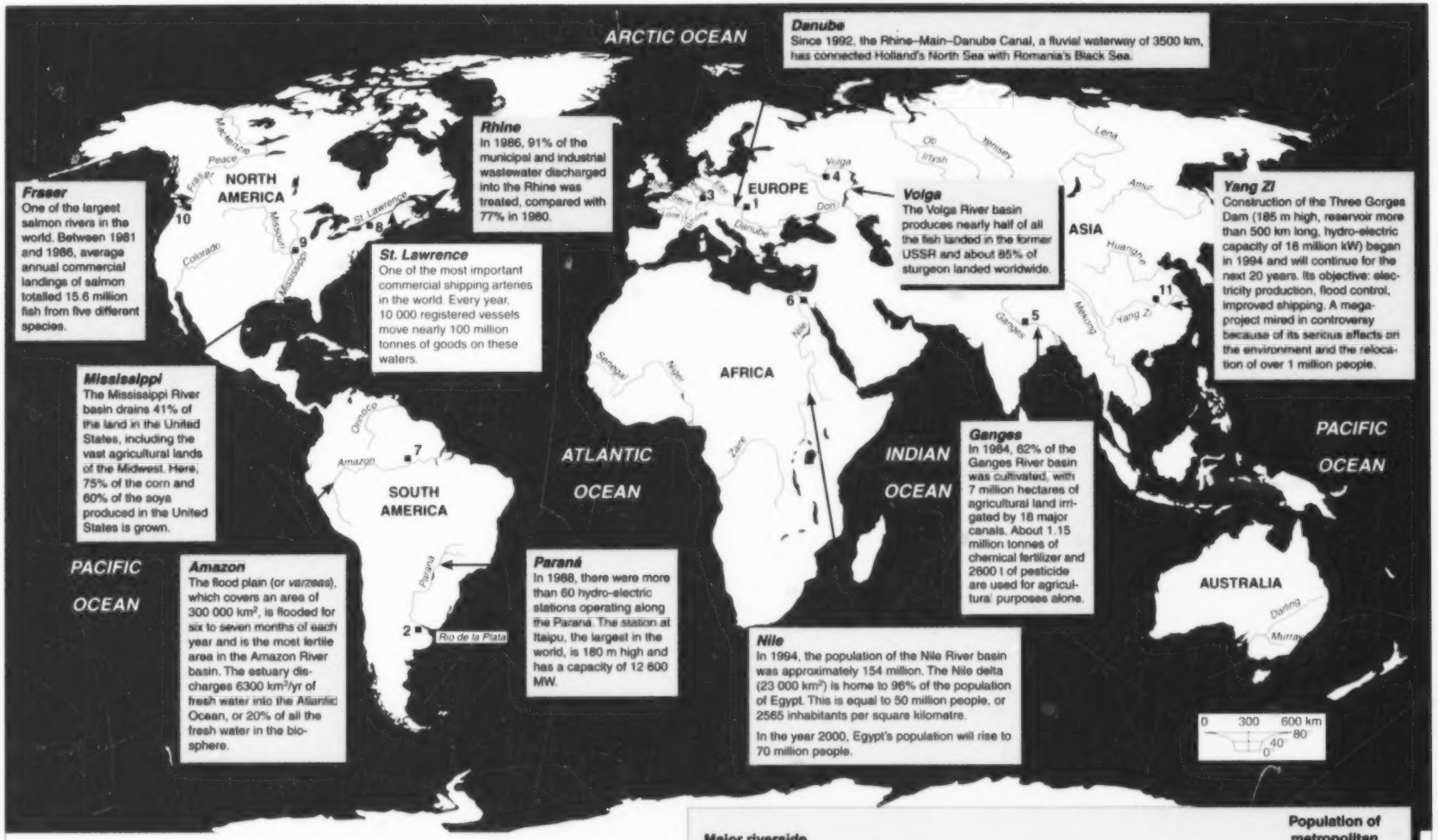
March 1997

INFO-FLASH 30

The St. Lawrence Compared to Other Major Rivers: Riverside Cities and Points of Interest



Fraser
One of the largest salmon rivers in the world. Between 1981 and 1986, average annual commercial landings of salmon totalled 15.6 million fish from five different species.

Rhine
In 1986, 91% of the municipal and industrial wastewater discharged into the Rhine was treated, compared with 77% in 1980.

Danube
Since 1992, the Rhine–Main–Danube Canal, a fluvial waterway of 3500 km, has connected Holland's North Sea with Romania's Black Sea.

St. Lawrence
One of the most important commercial shipping arteries in the world. Every year, 10 000 registered vessels move nearly 100 million tonnes of goods on these waters.

Volga
The Volga River basin produces nearly half of all the fish landed in the former USSR and about 85% of sturgeon landed worldwide.

Yang Zi
Construction of the Three Gorges Dam (185 m high, reservoir more than 500 km long, hydro-electric capacity of 18 million kW) began in 1994 and will continue for the next 20 years. Its objective: electricity production, flood control, improved shipping. A mega-project mired in controversy because of its serious effects on the environment and the relocation of over 1 million people.

Mississippi
The Mississippi River basin drains 41% of the land in the United States, including the vast agricultural lands of the Midwest. Here, 75% of the corn and 60% of the soya produced in the United States is grown.

Amazon
The flood plain (or *varzeas*), which covers an area of 300 000 km², is flooded for six to seven months of each year and is the most fertile area in the Amazon River basin. The estuary discharges 6300 km³/yr of fresh water into the Atlantic Ocean, or 20% of all the fresh water in the biosphere.

Paraná
In 1988, there were more than 60 hydro-electric stations operating along the Paraná. The station at Itaipu, the largest in the world, is 180 m high and has a capacity of 12 600 MW.

Ganges
In 1984, 62% of the Ganges River basin was cultivated, with 7 million hectares of agricultural land irrigated by 18 major canals. About 1.15 million tonnes of chemical fertilizer and 2600 t of pesticide are used for agricultural purposes alone.

Nile
In 1994, the population of the Nile River basin was approximately 154 million. The Nile delta (23 000 km²) is home to 96% of the population of Egypt. This is equal to 50 million people, or 2565 inhabitants per square kilometre.

In the year 2000, Egypt's population will rise to 70 million people.

Major riverside city	River	Country	Population of metropolitan area
1. **Budapest**	Danube	Hungary	2 104 700
2. **Buenos Aires**	Rio de la Plata (mouth of Paraná)	Argentina	12 595 000
3. **Cologne (Köln)**	Rhine	Germany	932 400
4. **Gorki**	Volga	Russia	1 445 000
5. **Kanpur**	Ganges	India	1 539 000
6. **Cairo**	Nile	Egypt	8 540 000
7. **Manaus**	Amazon	Brazil	635 000
8. **Montreal**	St. Lawrence	Canada	3 127 000
9. **St. Louis**	Mississippi	United States	2 938 400
10. **Vancouver**	Fraser	Canada	1 602 500
11. **Wuhan**	Yang Zi	China	3 832 000

Other large riverside cities:

Hamburg, Germany (Elbe): 1 617 800 inhab.

Kinshasa, Zaire (Zaire): 2 444 000 inhab.

London, England (Thames): 6 755 000 inhab.

Paris, France (Seine): 9 060 000 inhab.

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Source:
- Reader's Digest. 1993. *Guide to Places of the World: A Geographical Dictionary.*
- Various other sources.

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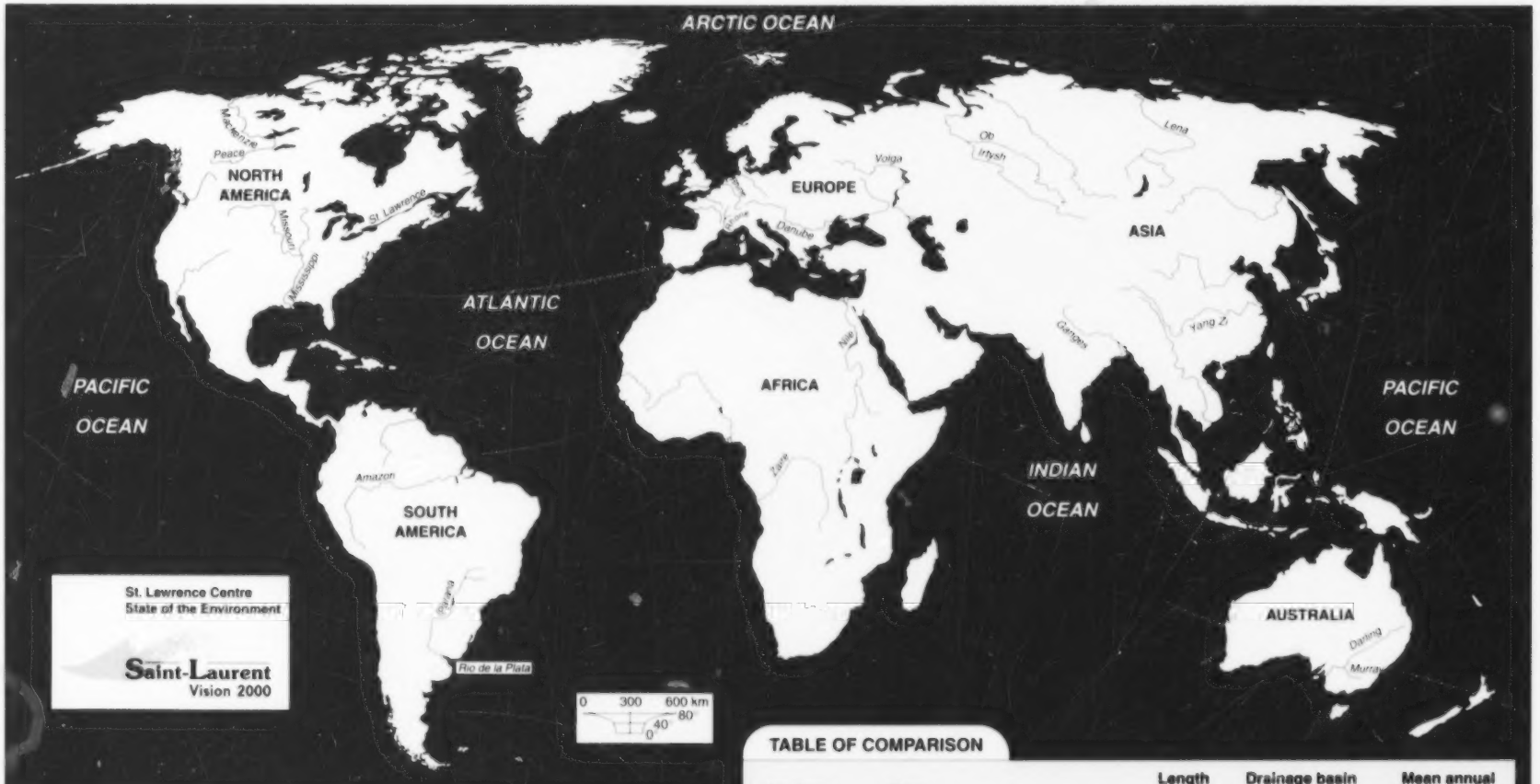
The St. Lawrence Compared to Other Major Rivers: Hydrographic Aspects



THE ST. LAWRENCE RIVER

Source: Great Lakes.

Outlet: Atlantic Ocean.

Tributaries: About 350 tributaries flow into the Quebec section of the River; there are some 100 on Anticosti Island.

Climate: Cold temperate with no dry season.

Population: 97% of Quebecers, or about 7 million people, live in the drainage basin.

RANKING

Length: 17th in the world.

Area of drainage basin:
- 13th in the world
- 3rd in North America after the Mississippi and Mackenzie rivers
- 2nd in Canada after the Mackenzie.

Mean annual flow rate: 15th in the world.

TABLE OF COMPARISON

Continent	River	Length (km)	Drainage basin (km²)	Mean annual flow rate (m³/s)
AFRICA	Nile	6 670	2 849 000	2 830
	Zaire (or Congo)	4 630	3 774 000	39 200
NORTH AMERICA	Mackenzie (and Peace)	4 240	1 787 000	9 600
	Mississippi (and Missouri)	5 970	3 290 000	18 400
	St. Lawrence (and Great Lakes)	**3 260**	**1 610 000**	**12 600**
SOUTH AMERICA	Amazon	6 570	6 300 000	175 000
	Parana (and Rio de la Plata)	4 880	3 100 000	25 000
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	Lena	4 400	2 430 000	16 300
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AUSTRALIA	Murray (and Darling)	3 750	1 059 000	350
EUROPE	Danube	2 860	817 000	6 550
	Rhine	1 320	185 000	2 500
	Rhone	810	96 000	2 200
	Volga	3 530	1 350 000	8 400

Source:
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INFO-FLASH 30

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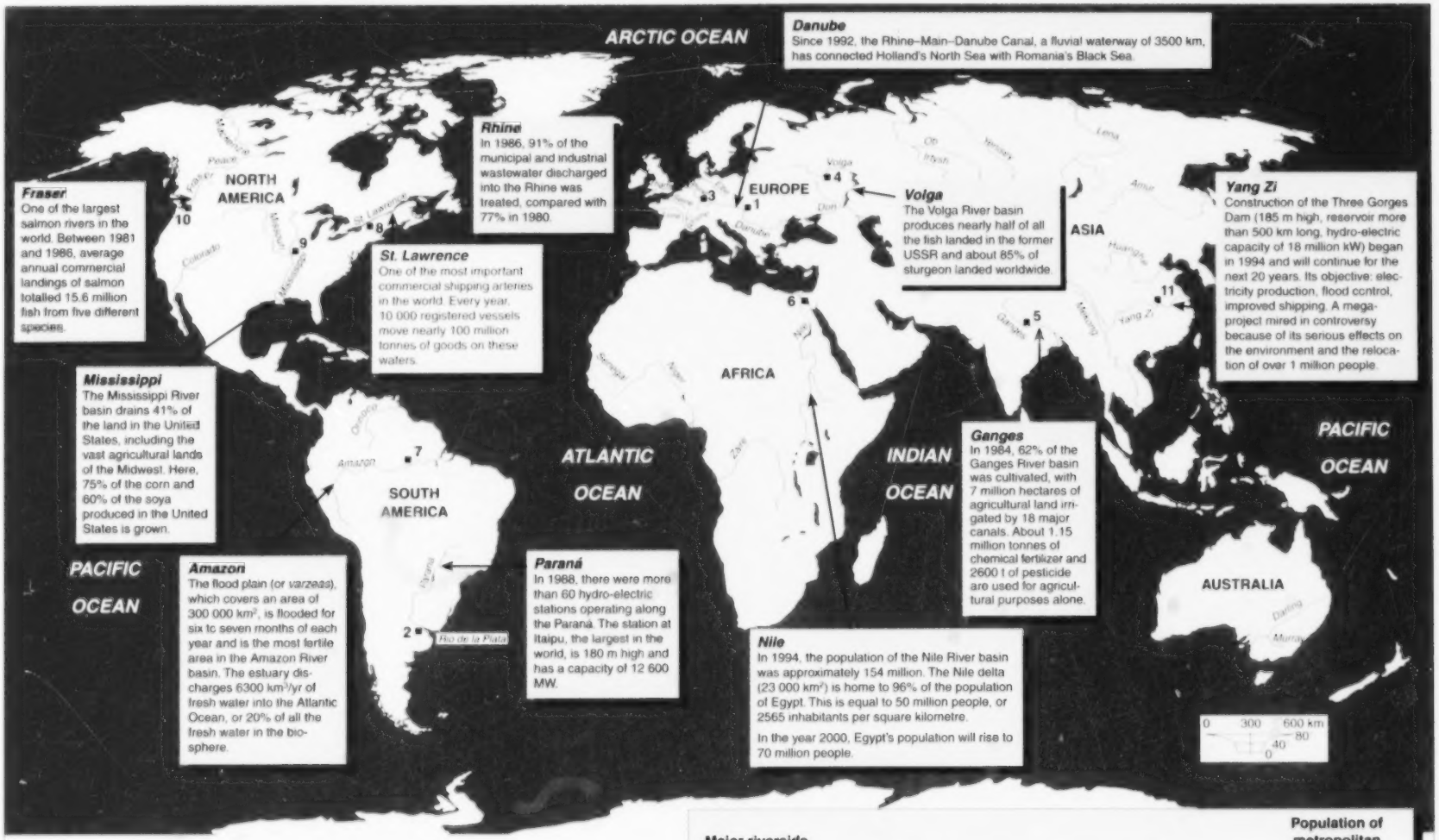

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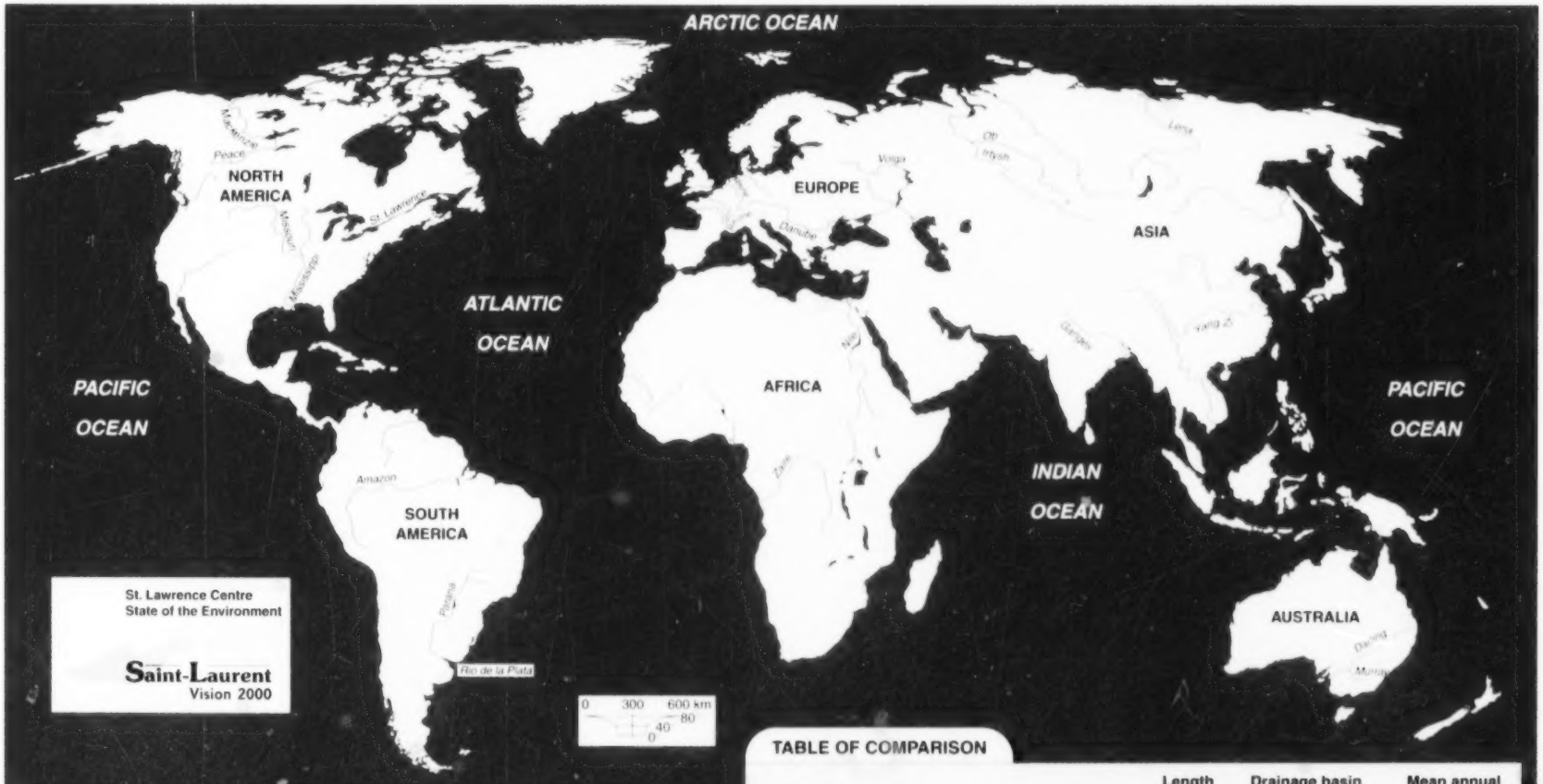

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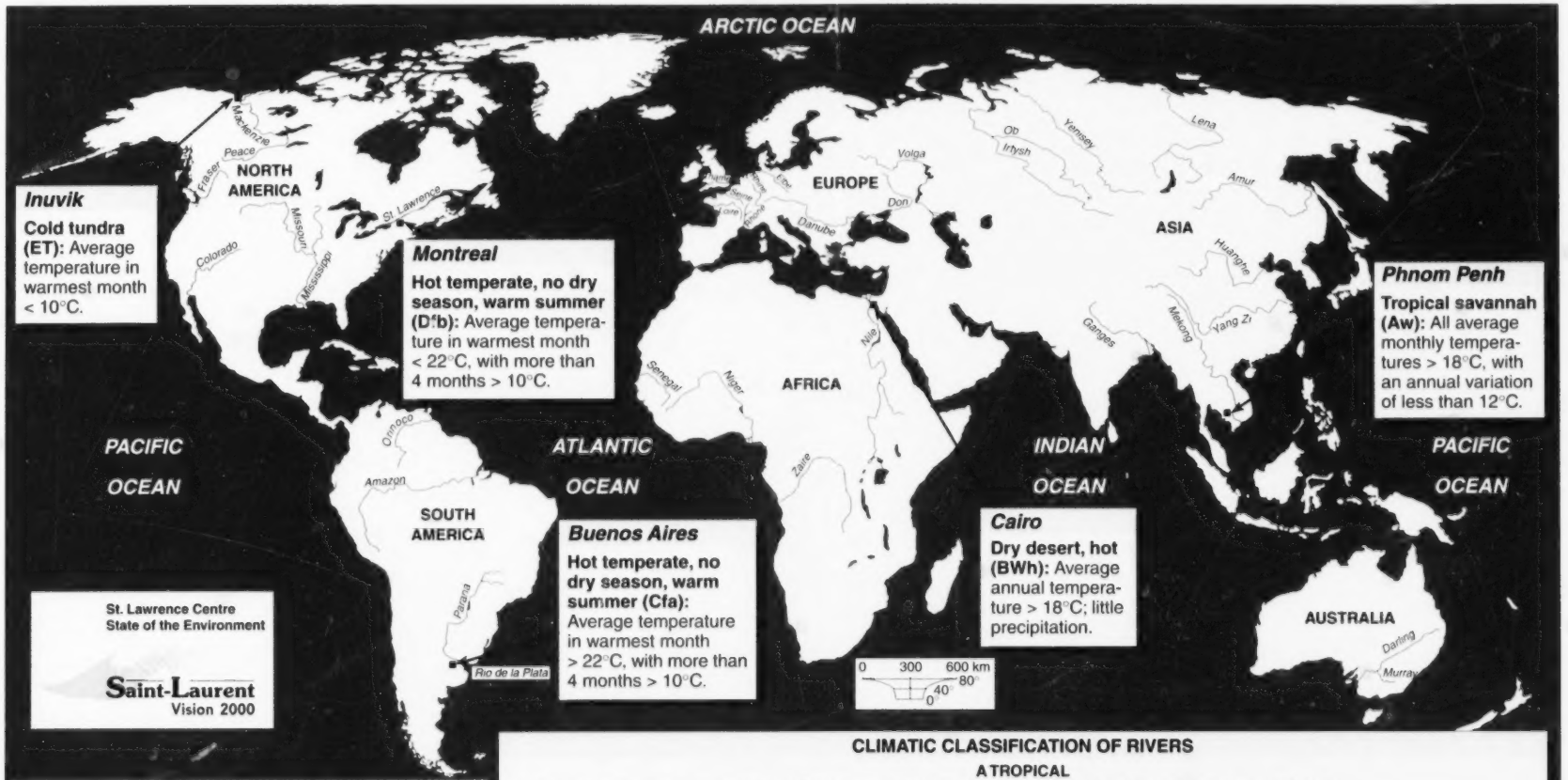
INFO-FLASH 32

The St. Lawrence Compared to Other Major Rivers: Climate



Inuvik

Cold tundra (ET): Average temperature in warmest month < 10°C.

Montreal

Hot temperate, no dry season, warm summer (Dfb): Average temperature in warmest month < 22°C, with more than 4 months > 10°C.

Phnom Penh

Tropical savannah (Aw): All average monthly temperatures > 18°C, with an annual variation of less than 12°C.

Buenos Aires

Hot temperate, no dry season, warm summer (Cfa): Average temperature in warmest month > 22°C, with more than 4 months > 10°C.

Cairo

Dry desert, hot (BWh): Average annual temperature > 18°C; little precipitation.

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A RIVER CAN TRAVEL THROUGH MANY DIFFERENT TYPES OF CLIMATE. For example, the Mekong River starts in a cold climate at an altitude of more than 1500 m (ETH) and flows successively through a cold temperate climate with no dry season (Dfc, Dfb), a hot temperate climate with a dry winter (Cwa), and empties into the China Sea, in an area whose climate is tropical savannah (Aw).

KÖPPEN'S CLIMATIC CLASSIFICATION

The first two letters of this classification indicate the major climatic groups (**A, B, C, D**) and their sub-groups (**f, m, w, s, S, W, T**). A third letter may be added for increased precision. These letters are: **a: hot summer, b: warm summer, c: cool, short summer, d: cool, short summer and cold winter, H: high-altitude (> 1500 m) climate.**

CLIMATIC CLASSIFICATION OF RIVERS

A TROPICAL

All average monthly temperatures > 18°C with annual variation of less than 6°C (Af and Am) and less than 12°C (Aw).

Af = rainforest → Amazon, Niger, Nile, Zaire
Am = monsoon → Amazon, Ganges, Orinoco
Aw = savannah → Amazon, Mekong, Niger, Nile, Orinoco, Paraná, Senegal, Zaire

B DRY

Average annual temperature may be: h = > 18°C (hot), k = < 18°C (cool).

BS = steppes → Amur, Colorado, Don, Huanghe, Mississippi, Murray, Niger, Nile, Ob, Senegal, Volga
BW = desert → Colorado, Niger, Nile, Senegal

C HOT TEMPERATE

Average temperature in coldest month is between 18°C and -3°C; in warmest month > 10°C.

Cw = dry winter → Amazon, Ganges, Huanghe, Mekong, Paraná, Yang Zi, Zaire
Cs = dry summer (Mediterranean) → Murray, Rhone
Cf = no dry season → Danube, Elbe, Fraser, Loire, Mississippi, Murray, Paraná, Rhine, Rhone, Seine, Thames, Yang Zi

D COLD TEMPERATE

Average temperature in coldest month < -3°C; in warmest month > 10°C.

Dw = dry winter → Amur, Huanghe, Yenisey, Lena
Df = no dry season → Colorado, Danube, Fraser, Huanghe, Yenisey, Lena, Mackenzie, Mekong, Mississippi, Rhone, Ob, **St. Lawrence**, Volga, Yang Zi

E COLD

Average temperature in warmest month < 10°C.

ET = tundra or altitude → Colorado, Huanghe, Yenisey, Lena, Mackenzie, Mekong, Yang Zi

Source: • Géo-Recherche D.G. enr. 1991. *Grands Fleuves. Dossier statistique.* For Environment Canada.
• *The Prentice Hall American World Atlas.* 1984. Climate plate.

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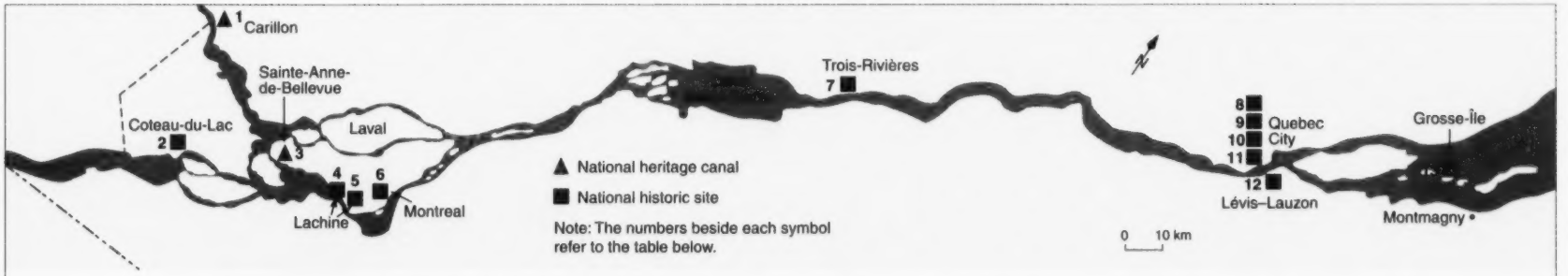
The St. Lawrence River – National Historic Sites (1995)



VISITS TO HISTORIC SITES IN 1995

Name of site	Description	Number of visitors
1. **Carillon Canal**	Military canal today used by pleasure craft.	32 167
2. **Coteau-du-Lac**	Site of military post and first lock canal in Canada.	38 214
3. **Sainte-Anne-de-Bellevue Canal**	Shipping canal today used by pleasure craft.	163 672
4. **Lachine Canal**	Shipping canal closed to navigation; currently under restoration.	526 439
5. **The Fur Trade at Lachine**	Important 19th century Montreal and Lachine fur trade site.	25 854
6. **Sir Georges-Étienne Cartier**	Home of one of the Fathers of Confederation.	17 593
7. **Forges du Saint-Maurice**	Remains of the first ironworks in Canada.	29 007
8. **Cartier-Brébeuf***	Site commemorating Jacques Cartier's exploration of the New World and the role of the Jesuits in the evangelization of the Native Indians.	67 424
9. **Fortifications of Québec**	Remains of military fortifications, including the Quebec Citadel.	2 965 529
10. **Artillery Park**	Structures and installations vital to the defence system of Quebec.	50 099
11. **The Old Port of Québec**	Interpretation centre for the timber and shipbuilding trades.	21 836
12. **Fort No. 1 at Pointe de Lévy***	Remains of a military fort built on Lévy Point between 1865 and 1872.	14 671
13. **Grosse Île and the Irish Memorial**	Quarantine station for European immigrants between 1832 and 1937.	14 321
14. **Pointe-au-Père Lighthouse**	Centre for piloting services and aids to navigation in the St. Lawrence Estuary.	18 069
15. **Battle of the Restigouche**	Site commemorating the naval battle of 1760 in which New France fell to the British.	21 742
TOTAL		**4 006 637**

* National historic site legally classified as a national historic park; that is, protected and governed by the *National Parks Act*.

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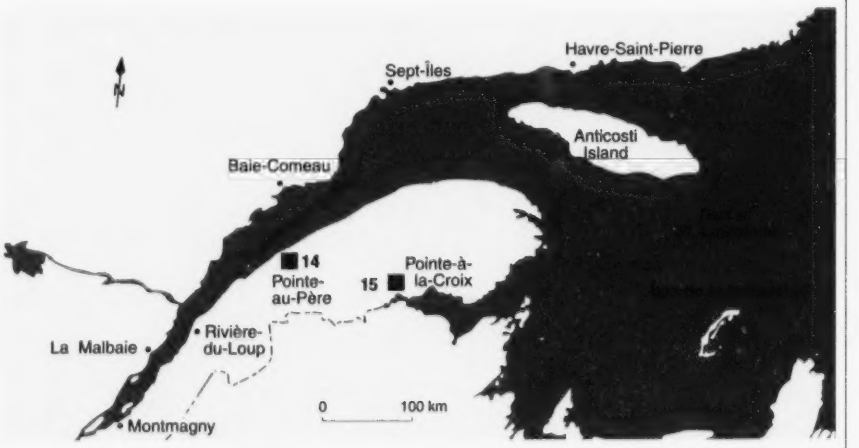

Source:
- Environment Canada. 1983. *Canada Parks Policy*. Canadian Parks Service.
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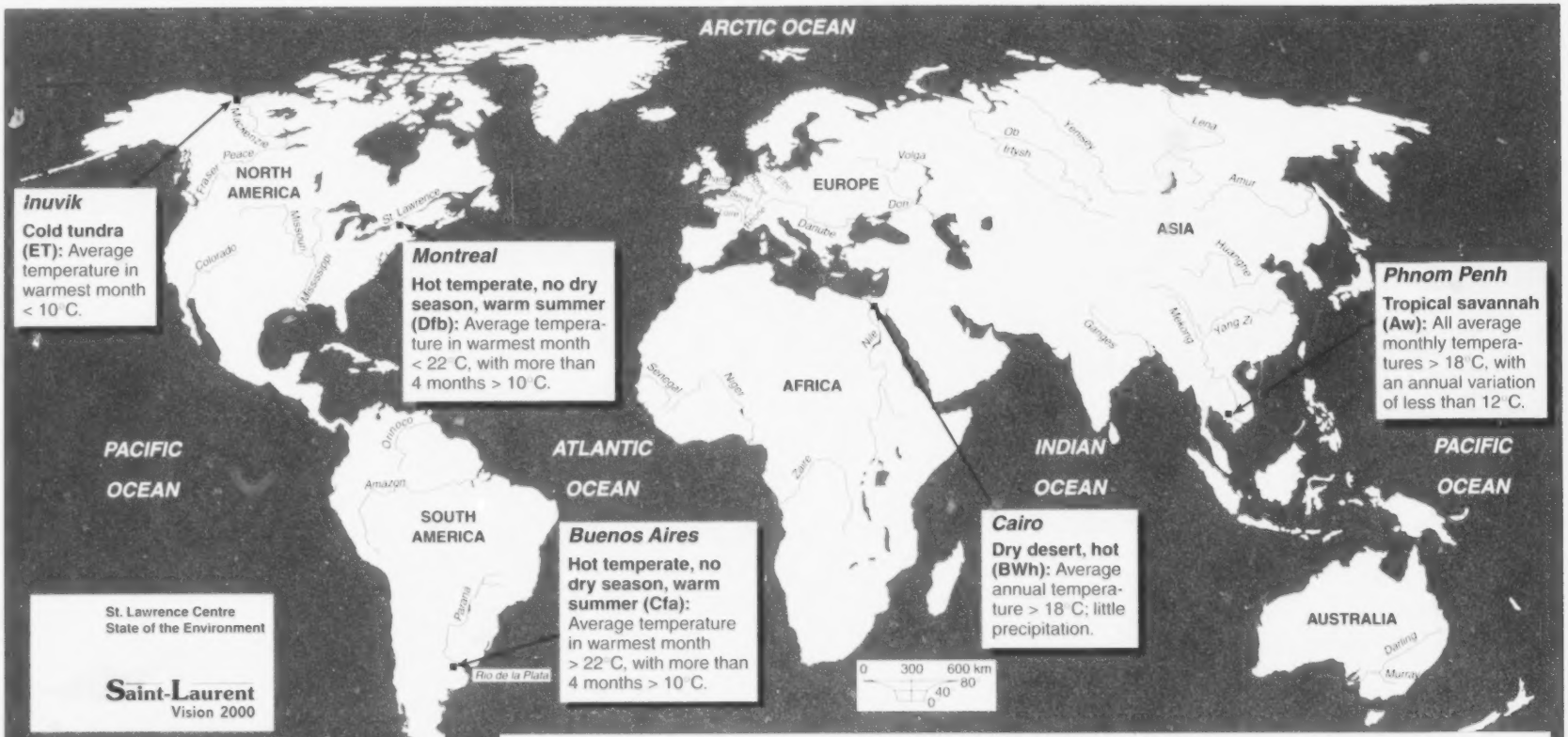
The St. Lawrence Compared to Other Major Rivers: Climate



Inuvik

Cold tundra (ET): Average temperature in warmest month < 10°C.

Montreal

Hot temperate, no dry season, warm summer (Dfb): Average temperature in warmest month < 22°C, with more than 4 months > 10°C.

Phnom Penh

Tropical savannah (Aw): All average monthly temperatures > 18°C, with an annual variation of less than 12°C.

Buenos Aires

Hot temperate, no dry season, warm summer (Cfa): Average temperature in warmest month > 22°C, with more than 4 months > 10°C.

Cairo

Dry desert, hot (BWh): Average annual temperature > 18°C; little precipitation.

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A RIVER CAN TRAVEL THROUGH MANY DIFFERENT TYPES OF CLIMATE. For example, the Mekong River starts in a cold climate at an altitude of more than 1500 m (ET) and flows successively through a cold temperate climate with no dry season (Dfc, Dfb), a hot temperate climate with a dry winter (Cwa), and empties into the China Sea, in an area whose climate is tropical savannah (Aw).

KÖPPEN'S CLIMATIC CLASSIFICATION

The first two letters of this classification indicate the major climatic groups (**A, B, C, D**) and their sub-groups (**f, m, w, s, S, W, T**). A third letter may be added for increased precision. These letters are: **a: hot summer, b: warm summer, c: cool, short summer, d: cool, short summer and cold winter, H: high-altitude (> 1500 m) climate.**

CLIMATIC CLASSIFICATION OF RIVERS

A TROPICAL

All average monthly temperatures > 18°C with annual variation of less than 6°C (Af and Am) and less than 12°C (Aw).

- **Af = rainforest** → Amazon, Niger, Nile, Zaire
- **Am = monsoon** → Amazon, Ganges, Orinoco
- **Aw = savannah** → Amazon, Mekong, Niger, Nile, Orinoco, Paraná, Senegal, Zaire

B DRY

Average annual temperature may be: h = > 18°C (hot), k = < 18°C (cool).

- **BS = steppes** → Amur, Colorado, Don, Huanghe, Mississippi, Murray, Niger, Nile, Ob, Senegal, Volga
- **BW = desert** → Colorado, Niger, Nile, Senegal

C HOT TEMPERATE

Average temperature in coldest month is between 18°C and -3°C; in warmest month > 10°C.

- **Cw = dry winter** → Amazon, Ganges, Huanghe, Mekong, Paraná, Yang Zi, Zaire
- **Cs = dry summer (Mediterranean)** → Murray, Rhone
- **Cf = no dry season** → Danube, Elbe, Fraser, Loire, Mississippi, Murray, Paraná, Rhine, Rhone, Seine, Thames, Yang Zi

D COLD TEMPERATE

Average temperature in coldest month < -3°C; in warmest month > 10°C.

- **Dw = dry winter** → Amur, Huanghe, Yenisey, Lena
- **Df = no dry season** → Colorado, Danube, Fraser, Huanghe, Yenisey, Lena, Mackenzie, Mekong, Mississippi, Rhone, Ob, **St. Lawrence**, Volga, Yang Zi

E COLD

Average temperature in warmest month < 10°C.

- **ET = tundra or altitude** → Colorado, Huanghe, Yenisey, Lena, Mackenzie, Mekong, Yang Zi

Source: • Géo-Recherche D.G. enr. 1991. *Grands Fleuves. Dossier statistique.* For Environment Canada.
• *The Prentice Hall American World Atlas.* 1984. Climate plate.

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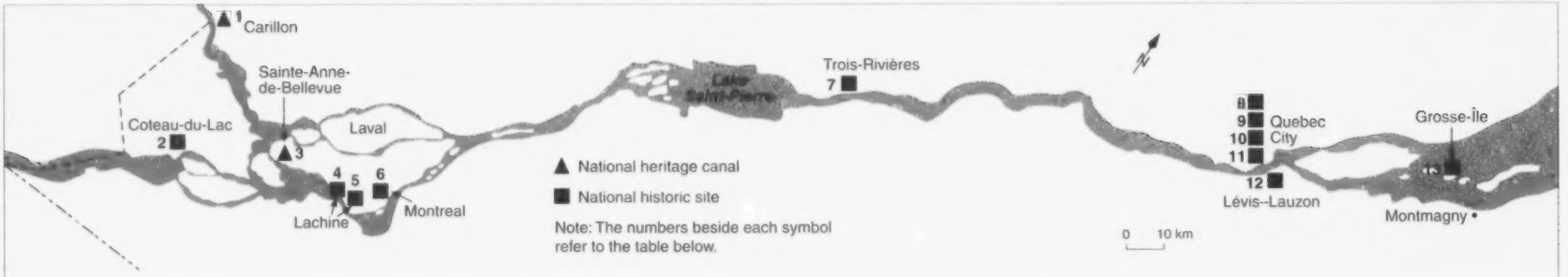
March 1997

The St. Lawrence River – National Historic Sites (1995)



VISITS TO HISTORIC SITES IN 1995

Name of site	Description	Number of visitors
1. **Carillon Canal**	Military canal today used by pleasure craft.	32 167
2. **Coteau-du-Lac**	Site of military post and first lock canal in Canada.	38 214
3. **Sainte-Anne-de-Bellevue Canal**	Shipping canal today used by pleasure craft.	163 672
4. **Lachine Canal**	Shipping canal closed to navigation; currently under restoration.	526 439
5. **The Fur Trade at Lachine**	Important 19th century Montreal and Lachine fur trade site.	25 854
6. **Sir Georges-Étienne Cartier**	Home of one of the Fathers of Confederation.	17 593
7. **Forges du Saint-Maurice**	Remains of the first ironworks in Canada.	29 007
8. **Cartier-Brébeuf***	Site commemorating Jacques Cartier's exploration of the New World and the role of the Jesuits in the evangelization of the Native Indians.	67 424
9. **Fortifications of Québec**	Remains of military fortifications, including the Quebec Citadel.	2 965 529
10. **Artillery Park**	Structures and installations vital to the defence system of Quebec.	50 099
11. **The Old Port of Québec**	Interpretation centre for the timber and shipbuilding trades.	21 836
12. **Fort No. 1 at Pointe de Lévy***	Remains of a military fort built on Lévy Point between 1865 and 1872.	14 671
13. **Grosse Île and the Irish Memorial**	Quarantine station for European immigrants between 1832 and 1937.	14 321
14. **Pointe-au-Père Lighthouse**	Centre for piloting services and aids to navigation in the St. Lawrence Estuary.	18 069
15. **Battle of the Restigouche**	Site commemorating the naval battle of 1760 in which New France fell to the British.	21 742
TOTAL		**4 006 637**

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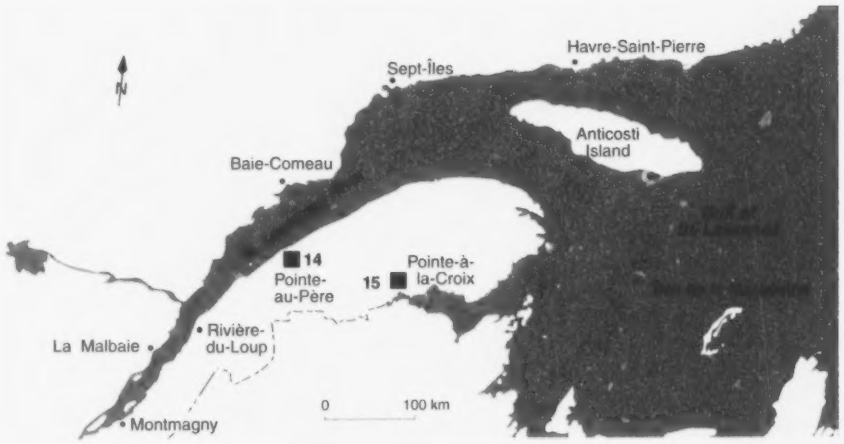

Source:
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- Environment Canada. 1991. *State of the Parks Report*. Canadian Parks Service.
- Parks Canada. 1996. *Statistical Report 1995 – Quebec Region*. Department of Canadian Heritage.

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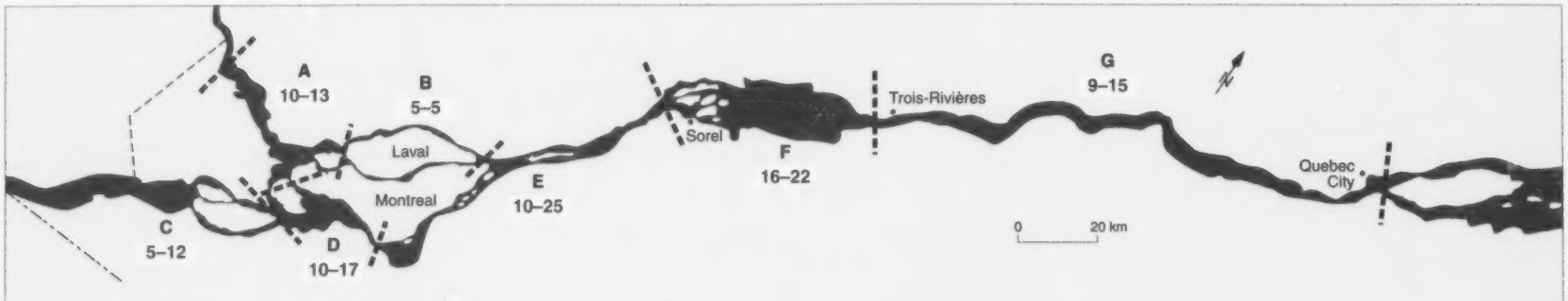
The St. Lawrence River – Boat-Launching Ramps (1982–87)



Body of water

- **A** Lake des Deux Montagnes
- **B** des Prairies and Mille Îles rivers
- **C** Lake Saint-François and Beauharnois Canal
- **D** Lake Saint-Louis
- **E** Montreal to Sorel
- **F** Lake Saint-Pierre and Sorel islands
- **G** Trois-Rivières to Quebec City
- **H** Downstream of Quebec City (north shore)
- **I** Downstream of Quebec City (south shore)
- **J** Saguenay River

Example

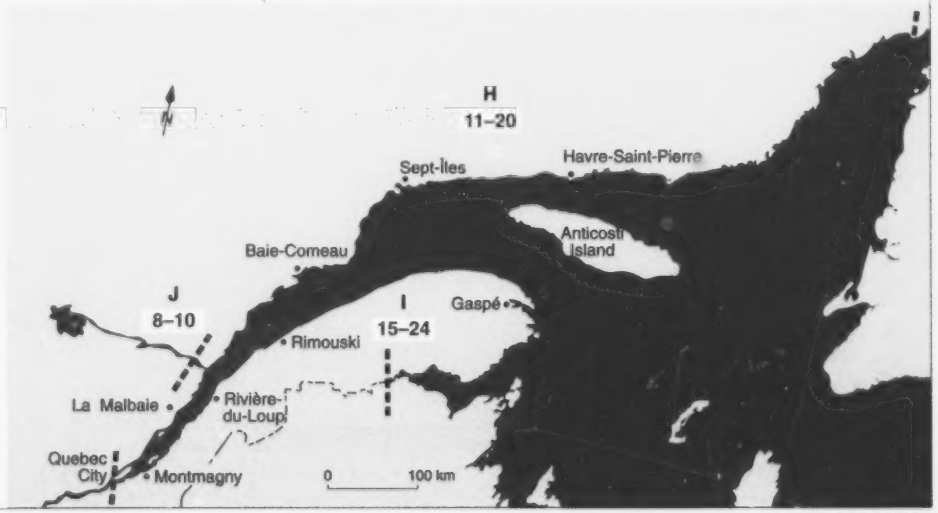
Number of launching ramps → Body of water: **E**, **10–25** → in 1982 / in 1987

LAUNCHING RAMPS (zones A to J)

	1982	1987
Federal ramps	12	36
Provincial ramps	12	7
Municipal ramps	8	14
Private ramps	67	106
Total	99	163
Number of riverside municipalities with one or more launching ramps	80	119

THE TOTAL NUMBER OF LAUNCHING RAMPS ALONG THE ST. LAWRENCE GREW BY 65% BETWEEN 1982 AND 1987. The largest increase, some 150%, occurred in the fluvial corridor between Montreal and Sorel (zone E).

In 1987, 65% of launching ramps belonged to private organizations, 22% were under federal jurisdiction, 4% provincial, and 9% municipal. In 1987, 31% of the 388 riverside municipalities had at least one launching ramp, compared to about 21% in 1982.



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Source:
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- Ministère du Loisir, de la Chasse et de la Pêche du Québec. 1982. *Randonnée nautique Québec 1982.*

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Canada

March 1997

The St. Lawrence River – Cetacean Characteristics

MYSTICETI

Common name (species)		Minke whale[a] (*Balaenoptera acutorostrata*)	Fin whale*[a] (*Balaenoptera physalus*)	Blue whale*[a] (*Balaenoptera musculus*)	Humpback whale*[b] (*Megaptera novaeangliae*)
Average length (metres)	♂	7 to 8	21 to 25	24 to 25	12
	♀	7 to 8	21 to 25	24 to 25	13
Average weight (tonnes)	♂	6 to 8	40 to 50	80 to 130	20 to 40
	♀	6 to 8	40 to 50	80 to 130	20 to 40
Average diving time (minutes)		3 to 8 (max. 20)	5 to 15	15 to 20 (max. 50)	10 to 15
Food		fish, crustaceans	fish, crustaceans (3 t/d)	small crustaceans (krill) (5 t/d)	fish, crustaceans

CETACEA (from the Greek *ketos*, meaning "big fish"):
An order of marine mammals perfectly adapted to aquatic life because of their fish-shaped bodies, whose front members have become fins while the rear members have disappeared or are vestigial.

CETACEA

- **MYSTICETI** (from the Greek *moustax*, meaning "mustache" and *ketos*, "big fish"). Whales which feed by filtering water through their baleen plates, retaining their prey.
- **ODONTOCETI** (from the Greek *odous*, meaning "tooth"). Whales which seize their prey with their teeth.

ONLY THE BELUGA lives year-round in the St. Lawrence. The other species are migratory and come here to feed before heading south.

The Sperm whale is an occasional visitor to the St. Lawrence: three were spotted in 1988 in the Jacques Cartier Strait and two in 1991 just off Tadoussac. The Killer whale is rarely seen in large numbers. Each year a pod of four is seen on the Lower North Shore (Basse-Côte-Nord).

ODONTOCETI

Common name (species)		Beluga whale*[a] (*Delphinapterus leucas*)	Killer whale[b] (*Orcinus orca*)	Pilot whale[b] (*Globicephala melaena*)	Harbour porpoise*[a] (*Phocoena phocoena*)	Sperm whale[c] (*Physeter macrocephalus*)	Atlantic white-sided dolphin[a] (*Lagenorhynchus acutus*)	White-beaked dolphin[c] (*Lagenorhynchus albirostris*)	Northern bottle-nosed whale[c] (*Hyperoodon ampullatus*)
Average length (metres)	♂	3.6 to 4.2	9	6	1.5	15	2.4	2.7	8.5
	♀	3 to 3.6	7	4.8	1.5	11	2.2	2.7	7.5
Average weight	♂	≈ 640 kg	8 tonnes	3.8 tonnes	40 to 80 kg	36 tonnes	130 to 230 kg	135 to 275 kg	5.5 tonnes
	♀	≈ 400 kg	4 tonnes	1.8 tonnes	40 to 60 kg	20 tonnes	130 to 230 kg	135 to 275 kg	4 tonnes
Average diving time (minutes)		10 to 15	1 to 4	5 to 10	3 to 6	30 to 50 (max. 90)	Undetermined	Undetermined	15 to 70
Food		fish, crustaceans, worms (25 kg/d)	fish, birds, marine mammals, shellfish	squid and occasionally fish (34 kg/d)	fish, crustaceans (4.5 kg/d)	large squid	squid and fish	fish, squid, crustaceans shellfish	squid, herring

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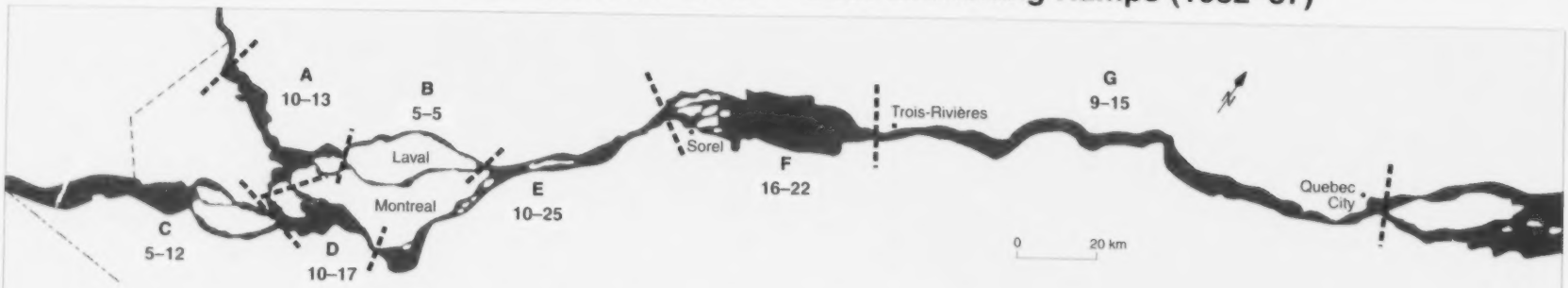

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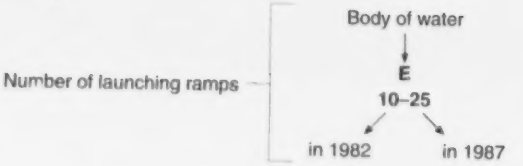

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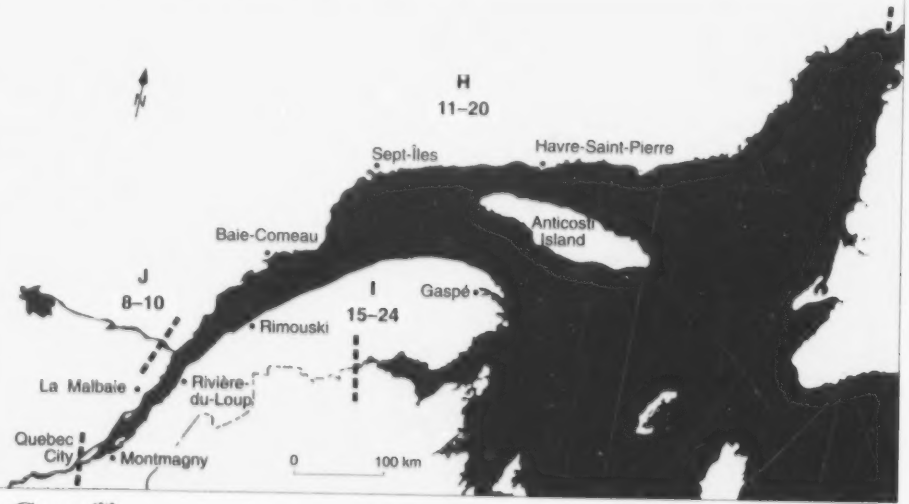

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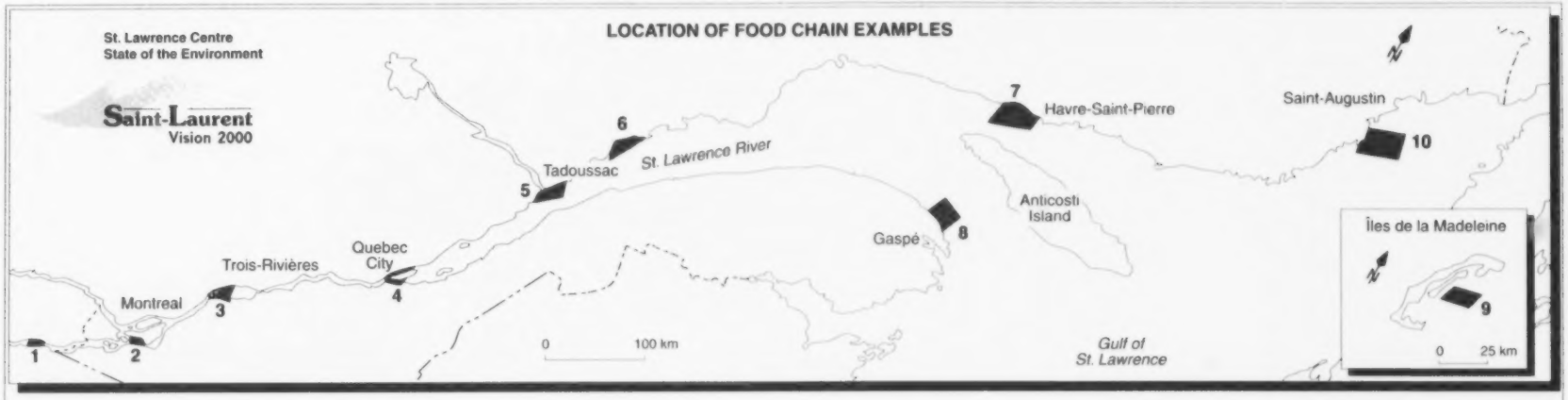
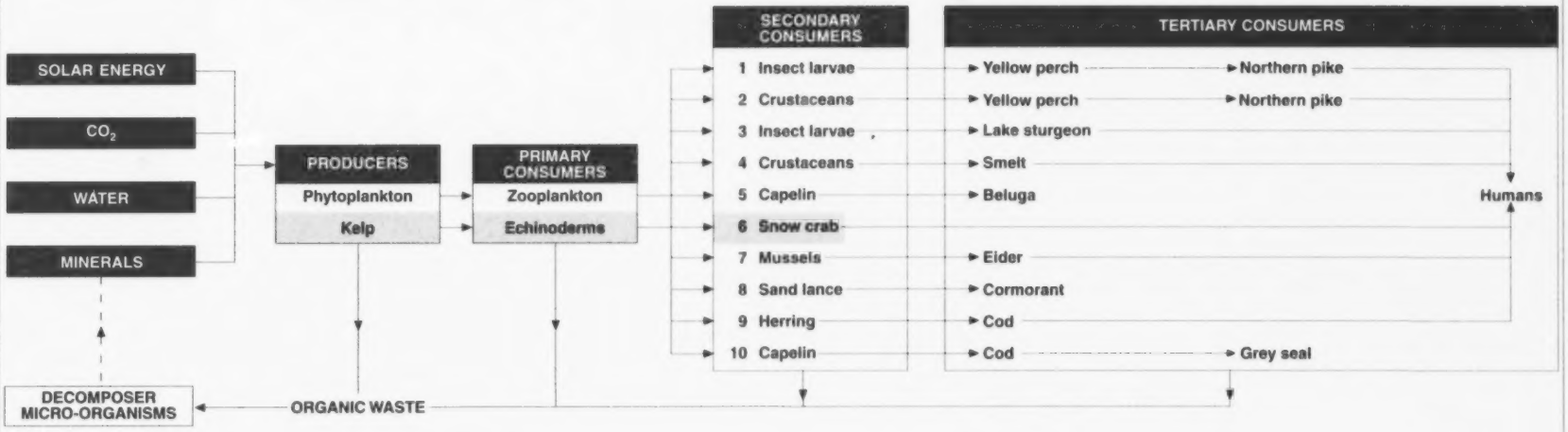
March 1997

The St. Lawrence River – Examples of Food Chains



LIVING CREATURES are united by food links. These links make up the food chain, or food web. The food chain ensures the circulation of matter and consequently the transfer of biochemical energy among the ecosystem's various organisms. The producers at the base of all food chains use solar energy, water, carbon dioxide and minerals to synthesize organic matter.

THE TOXIC SUBSTANCES discharged into the environment can accumulate in living organisms. Concentrations of toxic substances, often miniscule in the aquatic environment, can therefore reach very high values in living organisms (bioconcentration). The concentration of toxic substances may continue to increase in an organism throughout its lifetime (bioaccumulation). It may also grow from one link to another in the food chain (bioamplification).



Source: • Fisheries and Oceans. 1991. Fact sheets in the "Underwater World" series.
• St. Lawrence Centre. 1990. *Toxics in the St. Lawrence*. Environment Canada. "St. Lawrence UPDATE" series.

Environment Canada Environnement Canada
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March 1997

The St. Lawrence River – Rest Areas, Lookouts and Observation Sites

Symbol	Infrastructure	Number at riverside*	Jurisdiction
▲	Permanent rest areas	5	Ministère des Transports du Québec
△	Seasonal rest areas	52	Ministère des Transports du Québec
□	Lookouts	24	Ministère des Transports du Québec
●	Observation sites	23	Municipal or private
		1	Ministère de l'Environnement et de la Faune (Bic Conservation Park)
▣	Both lookouts and observation sites	2	Municipal
		107	

* These numbers do not include municipal riverside park infrastructures.

PERMANENT REST AREAS

Open year-round, these roadside stops offer picnic tables, snack bars and washrooms; accommodate thirty cars.

SEASONAL REST AREAS

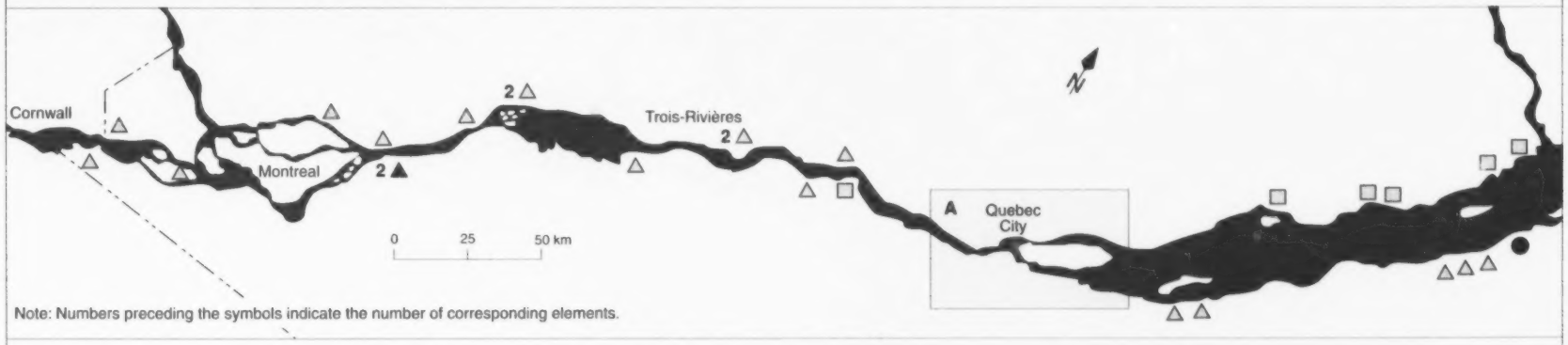
Roadside stops offering the same services as permanent rest areas, but only open six to eight months of the year.

LOOKOUTS

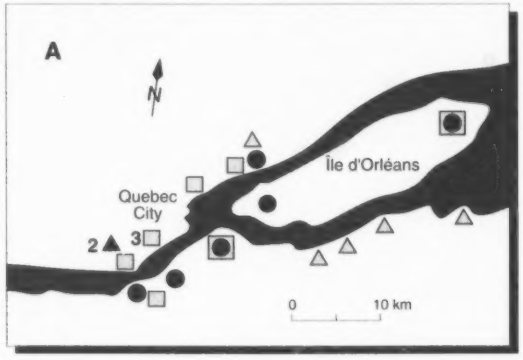
Former rest areas or by-roads with no infrastructure; safely accommodate three to four cars.

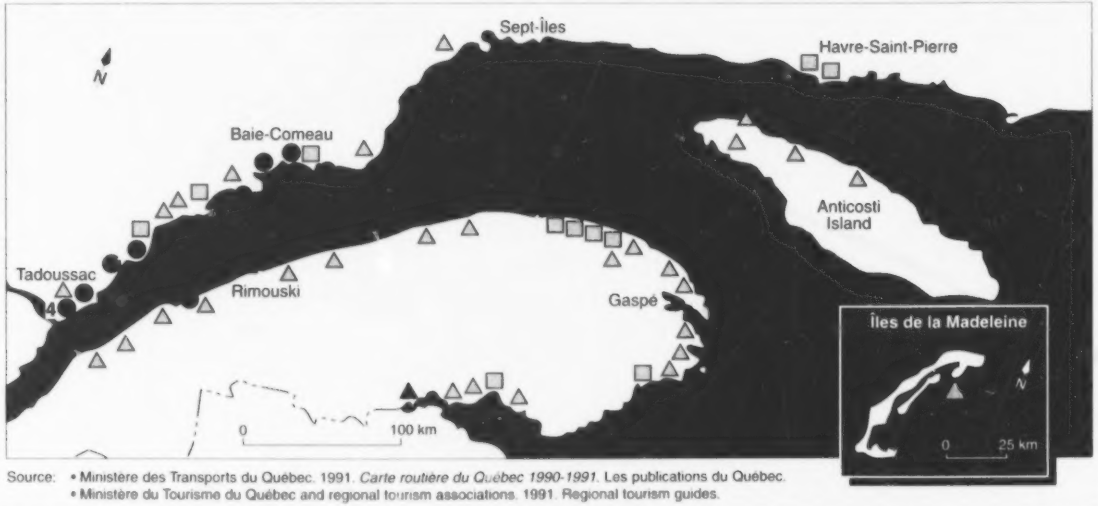
OBSERVATION SITES

Areas designed for observing the countryside and plant and animal life; also serve as destinations for long walks and hikes.



Note: Numbers preceding the symbols indicate the number of corresponding elements.





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Source: • Ministère des Transports du Québec. 1991. *Carte routière du Québec 1990-1991*. Les publications du Québec.
• Ministère du Tourisme du Québec and regional tourism associations. 1991. Regional tourism guides.

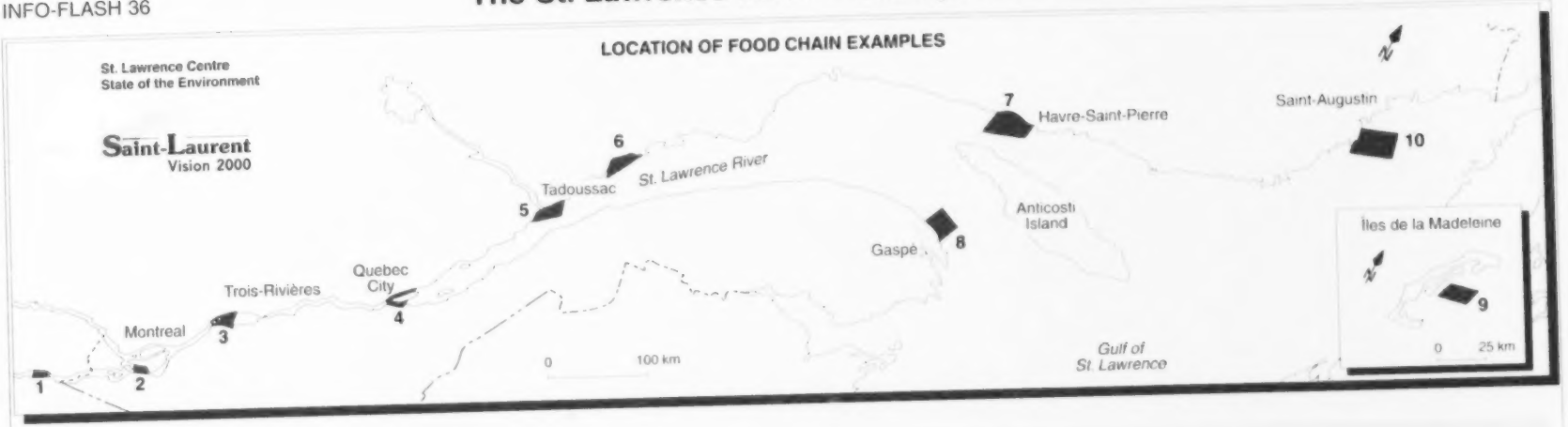
Environment Canada Environnement Canada

Canada

March 1997

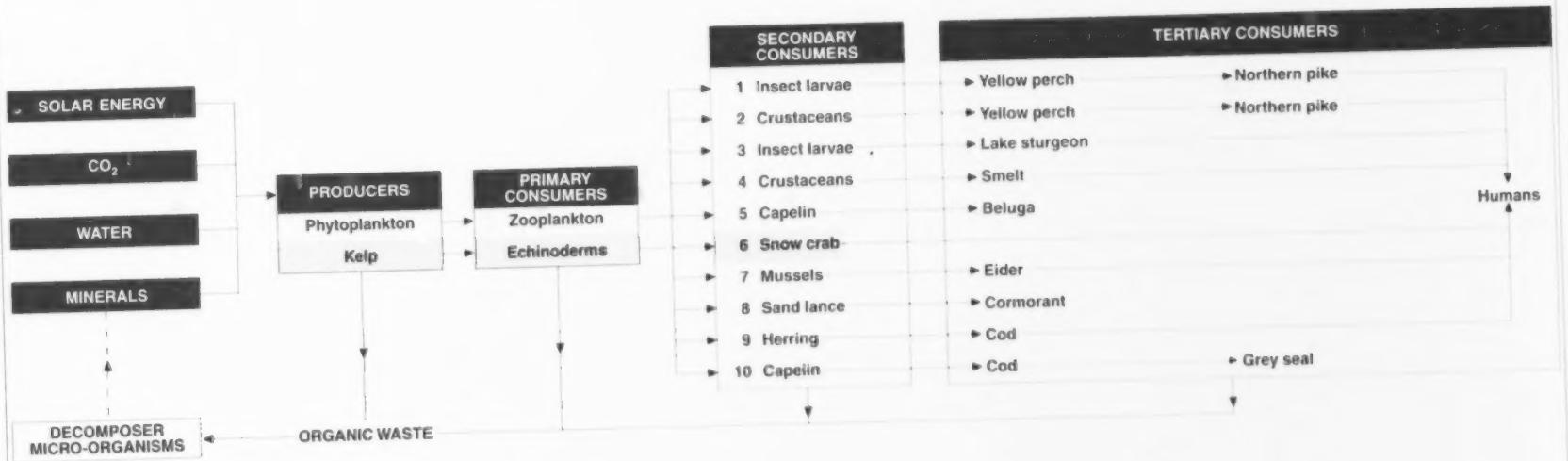
INFO-FLASH 36

The St. Lawrence River – Examples of Food Chains



LIVING CREATURES are united by food links. These links make up the food chain, or food web. The food chain ensures the circulation of matter and consequently the transfer of biochemical energy among the ecosystem's various organisms. The producers at the base of all food chains use solar energy, water, carbon dioxide and minerals to synthesize organic matter.

THE TOXIC SUBSTANCES discharged into the environment can accumulate in living organisms. Concentrations of toxic substances, often miniscule in the aquatic environment, can therefore reach very high values in living organisms (bioconcentration). The concentration of toxic substances may continue to increase in an organism throughout its lifetime (bioaccumulation). It may also grow from one link to another in the food chain (bioamplification).



Source: • Fisheries and Oceans. 1991. Fact sheets in the "Underwater World" series.
• St. Lawrence Centre. 1990. *Toxics in the St. Lawrence*. Environment Canada. "St. Lawrence UPDATE" series.

March 1997

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INFO-FLASH 37

The St. Lawrence River – Rest Areas, Lookouts and Observation Sites

Symbol	Infrastructure	Number at riverside*	Jurisdiction
▲	Permanent rest areas	5	Ministère des Transports du Québec
△	Seasonal rest areas	52	Ministère des Transports du Québec
□	Lookouts	24	Ministère des Transports du Québec
●	Observation sites	23	Municipal or private
		1	Ministère de l'Environnement et de la Faune (Bic Conservation Park)
▣	Both lookouts and observation sites	2	Municipal
		107	

* These numbers do not include municipal riverside park infrastructures.

PERMANENT REST AREAS

Open year-round, these roadside stops offer picnic tables, snack bars and washrooms; accommodate thirty cars.

SEASONAL REST AREAS

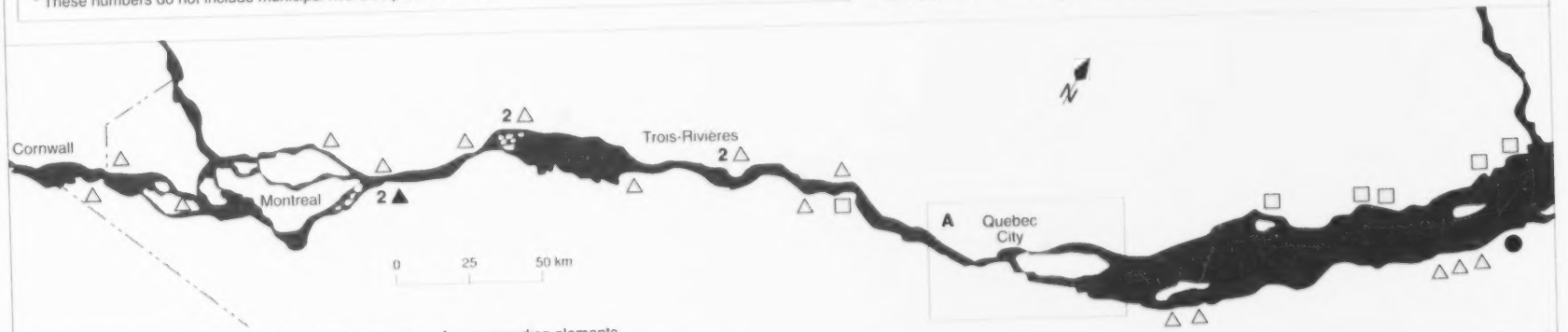
Roadside stops offering the same services as permanent rest areas, but only open six to eight months of the year.

LOOKOUTS

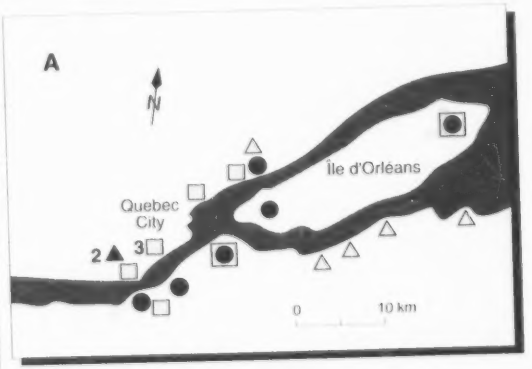
Former rest areas or by-roads with no infrastructure; safely accommodate three to four cars.

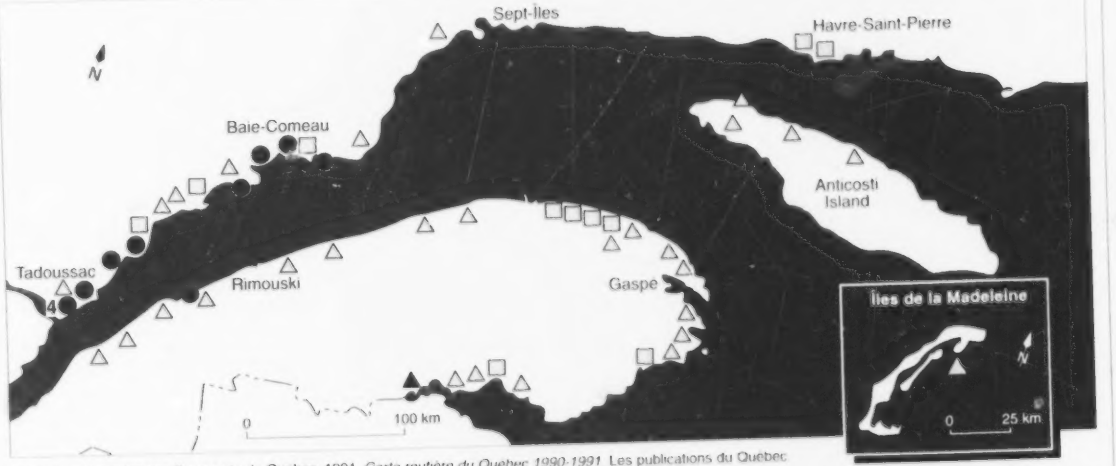
OBSERVATION SITES

Areas designed for observing the countryside and plant and animal life; also serve as destinations for long walks and hikes.



Note: Numbers preceding the symbols indicate the number of corresponding elements.





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The St. Lawrence River – Algal Contamination of Shellfish

St. Lawrence Centre
State of the Environment

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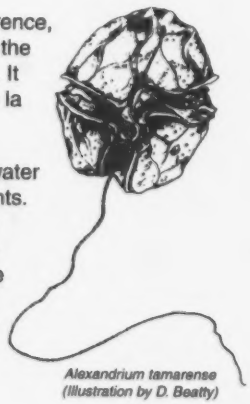
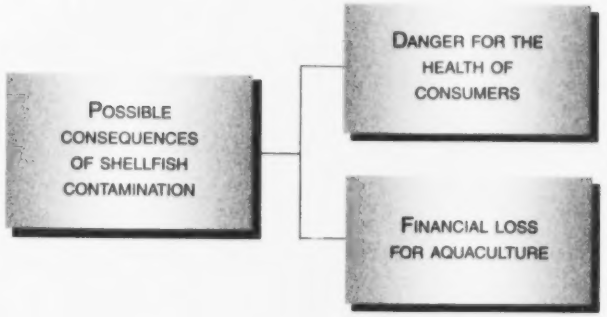
Vision 2000

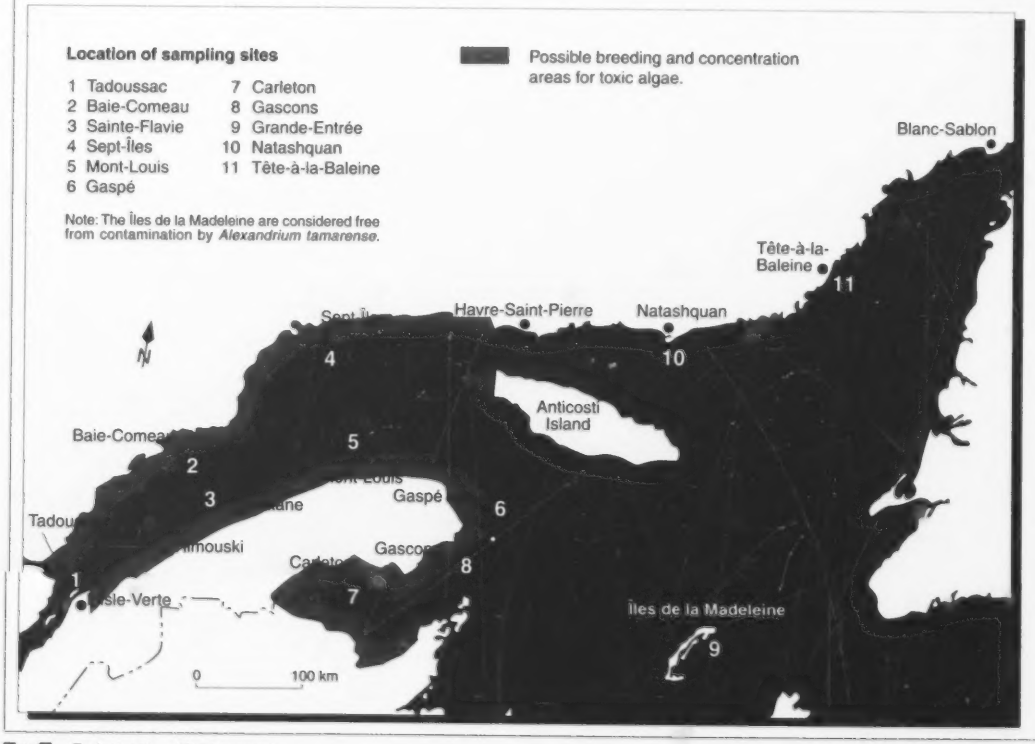
CERTAIN TYPES OF MICROSCOPIC ALGAE ARE TOXIC. In the St. Lawrence, *Alexandrium tamarense (Protogonyaulax tamarensis)*, is the only toxic species of *Alexandrium* found in significant numbers. It lives year-round along the Côte-Nord, the Gaspé and the Îles de la Madeleine.

These algae breed and concentrate in areas with suitable water temperature, salinity level, nutrient composition and currents. Bivalve molluscs, which feed by filtering water, absorb these algae, accumulate their toxins and become potentially hazardous. Other shellfish, both herbivores and omnivores, can also be contaminated. Every year in Quebec, some thirty cases of poisoning are reported, the result of negligence on the part of harvesters who ignore the directives issued by Fisheries and Oceans.



Alexandrium tamarense
(Illustration by D. Beatty)





Following various studies, and in the hopes of countering this natural phenomenon, a research program was initiated by the Maurice Lamontagne Institute of the Department of Fisheries and Oceans in 1989. Its aims are as follows:

1) To acquire new information on the ecology of algae.

2) To supply both the regional branch of Fisheries and Oceans and shellfish producers with data enabling them to predict the contamination of shellfish beds.

3) To allow Fisheries and Oceans to open or shut down harvest zones.

4) To determine the feasibility of establishing a warning system for producers and harvesters about the possibility of contamination.

As well, 11 water sampling sites allow toxic algae concentrations to be detected and analysed.

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The St. Lawrence River – Water Masses from Cornwall to Quebec City

St. Lawrence Centre
State of the Environment

Saint-Laurent
Vision 2000

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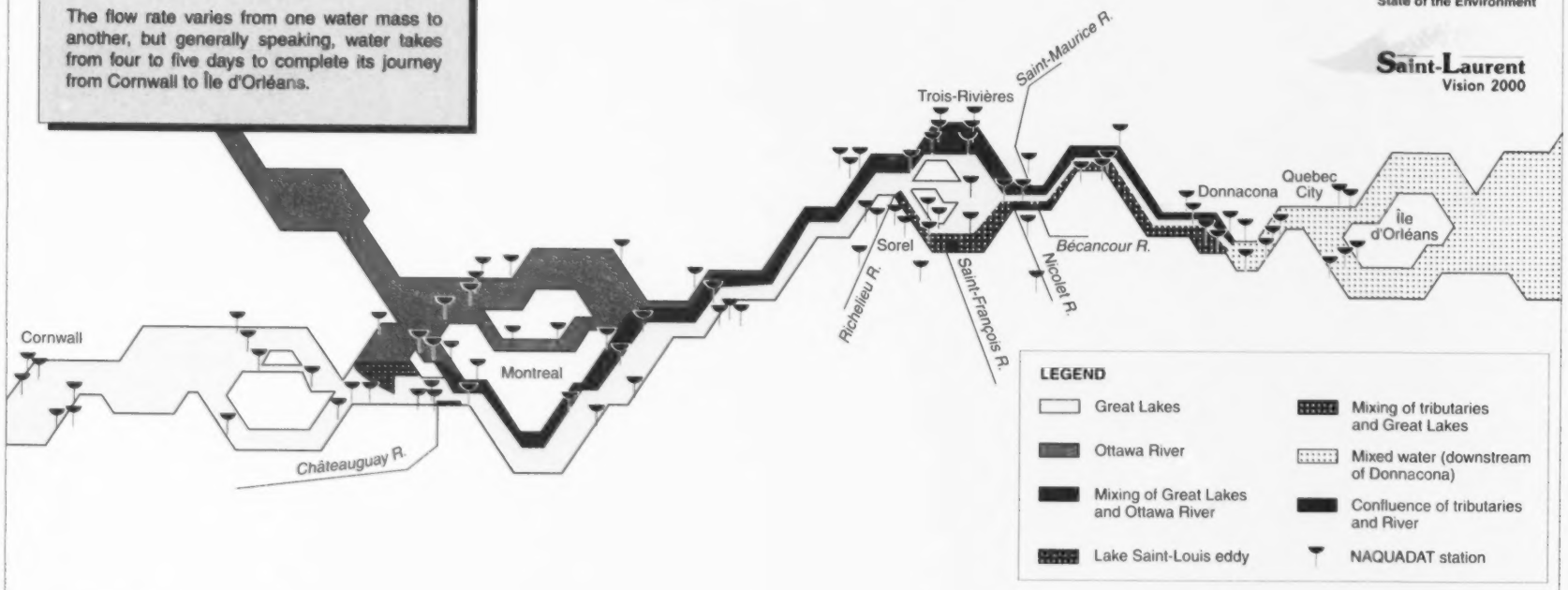
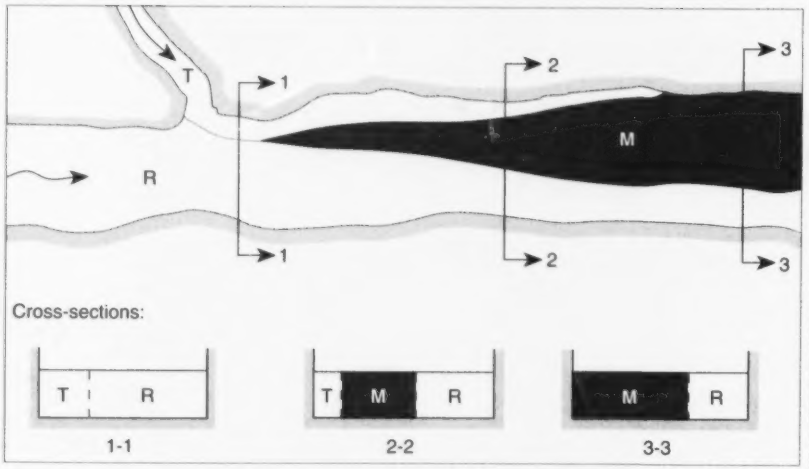


THE ST. LAWRENCE RIVER is made up of many water masses, each distinguished by its natural physico-chemical characteristics. The largest water masses are the green waters of the Great Lakes, high in minerals but only slightly turbid and low in nutrients, and the brown waters of the Ottawa River, characterized by their strong turbidity and low mineral content. Both meet in Lake Saint-Louis, where they gradually mix. Water masses can remain separate and distinct over long distances, depending on their properties. There are 12 water masses between Cornwall and Quebec City, six of which are formed by the confluence of the River and its tributaries (see figure). The quality of these waters is currently being monitored. Some 100 sampling stations between Cornwall and Quebec City collect data on 140 different parameters (physical, chemical, bacteriological, biological and hydrometric), and integrate them into the National Water Quality Data Bank (NAQUADAT) of Environment Canada.



Schematic diagram of a tributary (T) mixing (M) into the St. Lawrence River (R)

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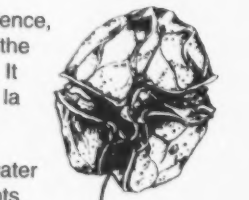

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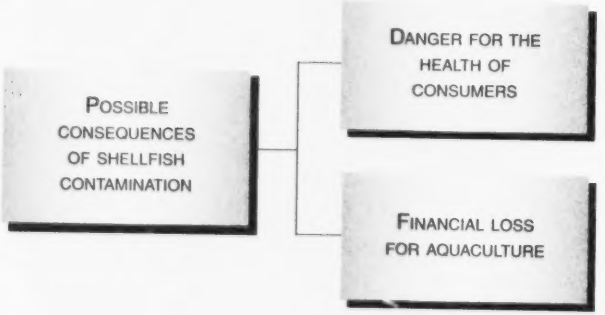

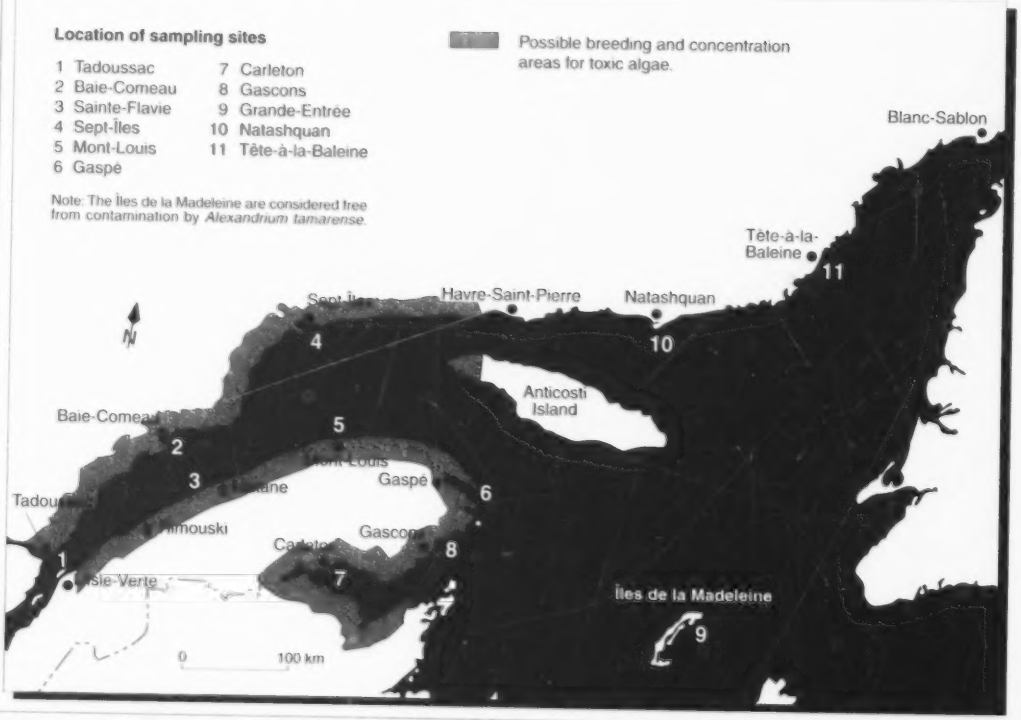

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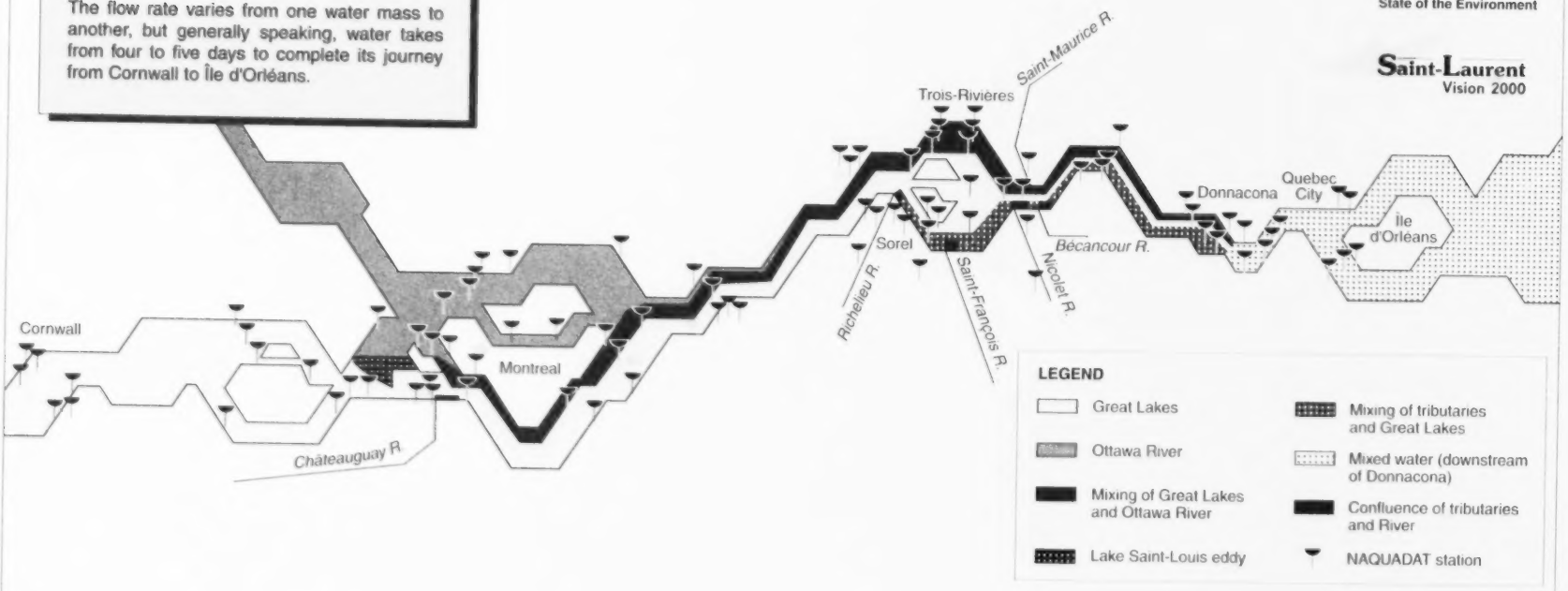

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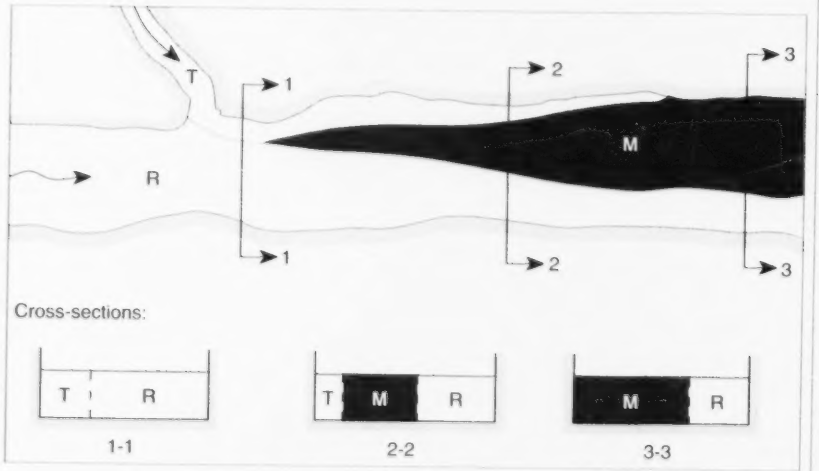

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The St. Lawrence River – Quality of Shellfish Waters in 1995

Why is water quality so important for filtering molluscs?

Certain types of molluscs, such as mussels and whelks, feed by filtering water. The amount of water filtered by one mussel in one hour, for example, can represent up to 300 times its weight. These shellfish concentrate the plankton and organic matter around them; in this way, when the waters of a shellfish bed are contaminated by fecal coliforms (bacteria from natural human and animal waste), the molluscs living there accumulate them. This does not affect the molluscs which absorb them, but does render them unfit for human consumption. Their consumption can lead to certain sicknesses, such as serious intestinal disruptions.

FEDERAL-PROVINCIAL SHELLFISH SANITATION COMMITTEE

FEDERAL JURISDICTION

Environment Canada

Sole intervenor in the bacteriological control of shellfish beds. In Quebec, this process is carried out under the Shellfish Water Quality Protection Program. It can recommend the closure of any areas not respecting standards set by the federal-provincial committee.

Fisheries and Oceans

Responsible for the quality control of products destined for export.
- Check for toxins in shellfish which lead to paralytic poisoning.
- Open or shut down shellfish areas depending on the toxins found or on bacterial or chemical contamination.
- Monitor areas closed to harvesting.

PROVINCIAL JURISDICTION

Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec

Charged with ensuring the quality control of products destined for local markets and tourists.

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Control municipal contamination sources through the Quebec waters cleanup program (PAEQ).

SHELLFISH WATER QUALITY PROTECTION PROGRAM

A PROGRAM TO MONITOR THE BACTERIOLOGICAL QUALITY OF WATER WHERE BIVALVE MOLLUSCS, ESPECIALLY MUSSELS AND CLAMS, ARE HARVESTED OR PRODUCED.

The function of this program:

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CLASSIFICATION OF THE 191 SHELLFISH AREAS EVALUATED IN 1995
(Number of areas open, closed or open conditionally, by region)

CLASSIFICATION

O : Area permanently open to harvest

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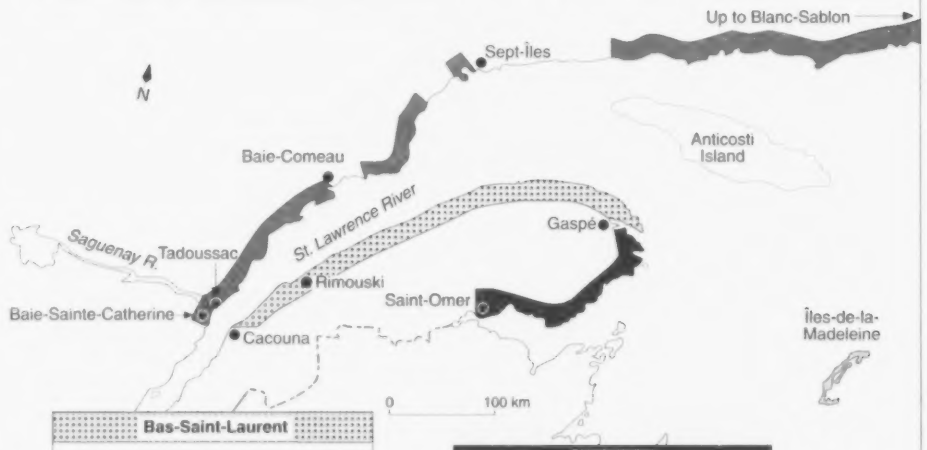
Charlevoix–Côte-Nord

	O	OC	C	Total
Number of areas	35	15	41	91
Percentage	38	17	45	100



Bas-Saint-Laurent

	O	OC	C	Total
Number of areas	4	1	24	29
Percentage	14	3	83	100

Gaspésie

	O	OC	C	Total
Number of areas	4	8	42	54
Percentage	7	15	78	100

SHELLFISH AREAS EVALUATED IN 1995

	O	OC	C	Total
Number of areas	55	26	110	191
Percentage	29	14	57	100

Îles-de-la-Madeleine

	O	OC	C	Total
Number of areas	12	2	3	17
Percentage	70	12	18	100

Source: • Environmental Protection Program. 1995. *Shellfish Water Quality Protection Program.* Environment Canada. Information pamphlet.
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March 1997

The St. Lawrence River and Mussel Farming

THE BLUE MUSSEL (*Mytilus edulis*)

Biology of the species

The Blue mussel is a bivalve mollusc of the Mytilidae family. This organism is a bottom dweller that uses its branchiae to feed on suspended organic matter in the water by the process of filtration. It attaches itself to firm sea bottoms at levels no deeper than 10 m, often grouping together into compact mussel banks. A mussel's growth is mainly influenced by the temperature of the water and the quality and quantity of food available.

Natural characteristics that facilitate mussel farming

- Widely distributed along the coasts of the St. Lawrence Estuary and Gulf
- Resistant to variations in water temperature and salinity
- Filter feeders requiring no structured feeding
- Gregarious nature allows a high-density breeding level to be maintained
- Habit of living attached to the earth (sessile) means that artificial supports may be employed instead of baskets or breeding pens.

What's more, the rapid growth and high meat yield of the cultivated Blue mussel ensures a relatively short production cycle and a high quality product whose commercial value is vastly superior to that of its harvested cousin, the natural or "wild" mussel.

TOTAL SALES OF BLUE MUSSELS IN QUEBEC

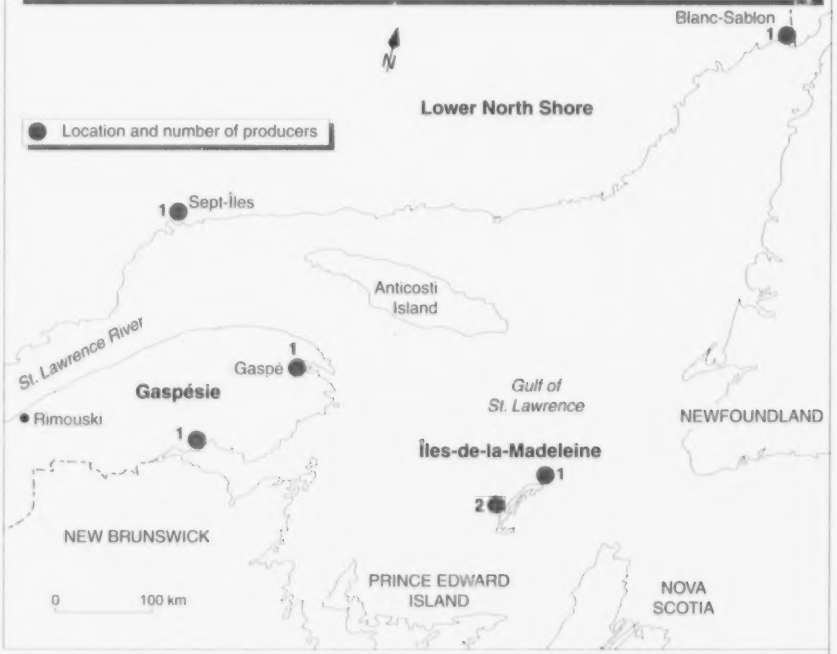
TOTAL SALES (in tonnes)	
1989	179.0
1990	126.0
1991	79.5
1992	86.5
1993	34.0
1994	31.0
1995	49.8

MUSSEL FARMING REGIONS IN 1995

Seven producers share **seven** permits.

The sales volume in 1995 totaled 49.8 tonnes and came mostly from the Îles-de-la-Madeleine region. Production in the Gaspé and the Lower North Shore (Basse-Côte-Nord) was too low to be recorded.

	Number of producers	Number of permits	Production (t)
Lower North Shore	2	2	negligible
Gaspésie	2	2	negligible
Îles-de-la-Madeleine	3	3	49.8



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- Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec. 1996. Personal communication.

THE CONSUMPTION OF BLUE MUSSELS

CANADIANS CONSUMED 3348 t OF MUSSELS IN 1989, 75% of which were eaten in the cities of Montreal, Toronto, Ottawa and Quebec. Ninety percent of these mussels came from farms on the East Coast, primarily Prince Edward Island, with 2440 t. It is estimated that 80% of mussels consumed by humans are cultivated, the rest being natural or "wild" mussels.

Mussels cultivated in Quebec (the Gaspé, Îles-de-la-Madeleine and Lower North Shore) represent only a small fraction of sales and are mainly eaten locally and, to some extent, in Montreal and Quebec City. Annual consumption in Quebec was estimated at some 2000 t in 1987 (both natural and cultivated mussels), of which only 3% came from Quebec's mussel farms.

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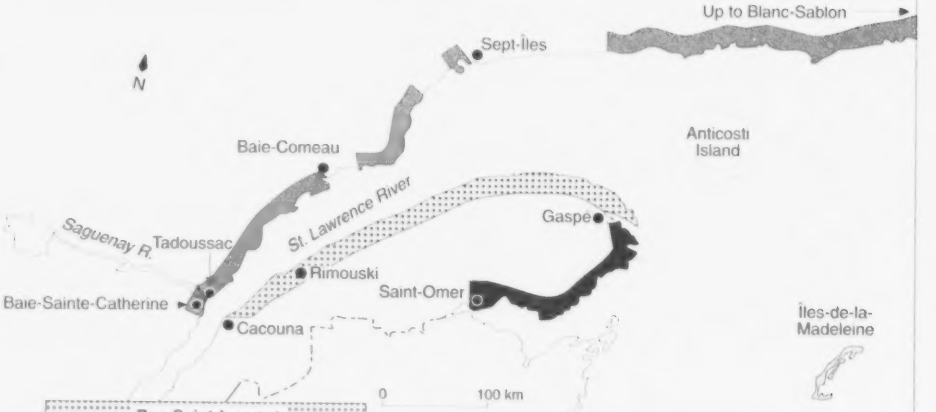

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THE BLUE MUSSEL (*Mytilus edulis*)

Biology of the species

The Blue mussel is a bivalve mollusc of the Mytilidae family. This organism is a bottom dweller that uses its branchiae to feed on suspended organic matter in the water by the process of filtration. It attaches itself to firm sea bottoms at levels no deeper than 10 m, often grouping together into compact mussel banks. A mussel's growth is mainly influenced by the temperature of the water and the quality and quantity of food available.

Natural characteristics that facilitate mussel farming

- Widely distributed along the coasts of the St. Lawrence Estuary and Gulf
- Resistant to variations in water temperature and salinity
- Filter feeders requiring no structured feeding
- Gregarious nature allows a high-density breeding level to be maintained
- Habit of living attached to the earth (sessile) means that artificial supports may be employed instead of baskets or breeding pens.

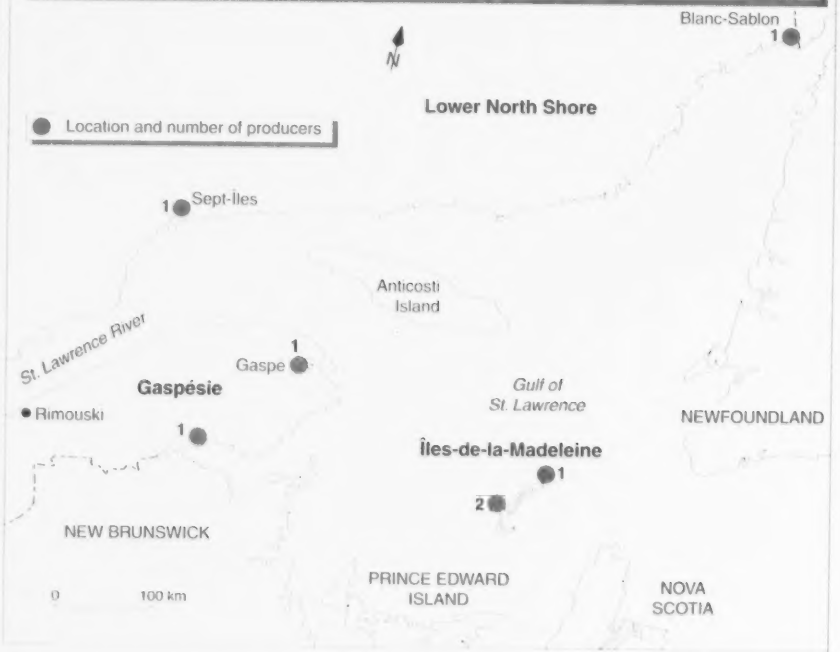
What's more, the rapid growth and high meat yield of the cultivated Blue mussel ensures a relatively short production cycle and a high quality product whose commercial value is vastly superior to that of its harvested cousin, the natural or "wild" mussel.

MUSSEL FARMING REGIONS IN 1995

Seven producers share **seven** permits.

The sales volume in 1995 totaled 49.8 tonnes and came mostly from the Îles-de-la-Madeleine region. Production in the Gaspé and the Lower North Shore (Basse-Côte-Nord) was too low to be recorded.

	Number of producers	Number of permits	Production (t)
Lower North Shore	2	2	negligible
Gaspésie	2	2	negligible
Îles-de-la-Madeleine	3	3	49.8



TOTAL SALES OF BLUE MUSSELS IN QUEBEC

TOTAL SALES (in tonnes)	
1989	179.0
1990	126.0
1991	79.5
1992	86.5
1993	34.0
1994	31.0
1995	49.8

Source
- Fisheries and Oceans. 1987. *Mussels Culture in Quebec. Description of the Production Cycle and Financial Analysis of a Typical Mussel Firm.*
- Ministère de l'Agriculture, des Pecheries et de l'Alimentation du Québec. 1996. Personal communication.

THE CONSUMPTION OF BLUE MUSSELS

CANADIANS CONSUMED 3348 t OF MUSSELS IN 1989, 75% of which were eaten in the cities of Montreal, Toronto, Ottawa and Quebec. Ninety percent of these mussels came from farms on the East Coast, primarily Prince Edward Island, with 2440 t. It is estimated that 80% of mussels consumed by humans are cultivated, the rest being natural or "wild" mussels.

Mussels cultivated in Quebec (the Gaspé, Îles-de-la-Madeleine and Lower North Shore) represent only a small fraction of sales and are mainly eaten locally and, to some extent, in Montreal and Quebec City. Annual consumption in Quebec was estimated at some 2000 t in 1987 (both natural and cultivated mussels), of which only 3% came from Quebec's mussel farms.

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The St. Lawrence River and the Tide

DEFINITIONS

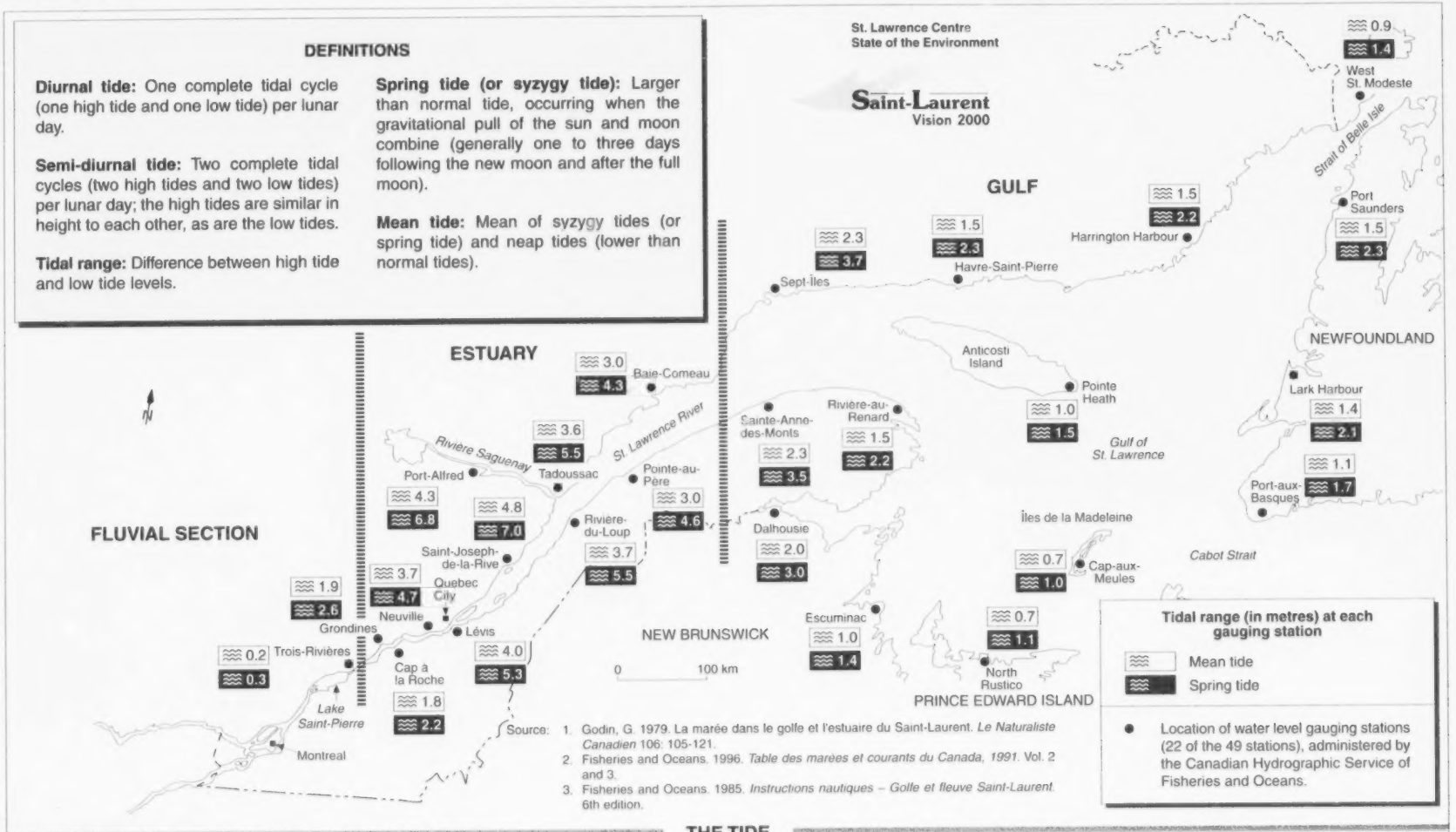
Diurnal tide: One complete tidal cycle (one high tide and one low tide) per lunar day.

Semi-diurnal tide: Two complete tidal cycles (two high tides and two low tides) per lunar day; the high tides are similar in height to each other, as are the low tides.

Tidal range: Difference between high tide and low tide levels.

Spring tide (or syzygy tide): Larger than normal tide, occurring when the gravitational pull of the sun and moon combine (generally one to three days following the new moon and after the full moon).

Mean tide: Mean of syzygy tides (or spring tide) and neap tides (lower than normal tides).



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1. Godin, G. 1979. La marée dans le golfe et l'estuaire du Saint-Laurent. *Le Naturaliste Canadien* 106: 105-121.
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THE TIDE

THE TIDE IS THE DAILY CYCLE OF THE SEA'S alternating rise and fall caused by the gravitational attraction of the moon in relation to the Earth's rotation. In many regions, tides are mixed, meaning they are formed of a combination of diurnal and semi-diurnal tides (see above), whose relative phases and amplitudes change from place to place. The Atlantic Ocean is dominated by semi-diurnal tides.

THE PROPAGATION OF THE TIDE

The Gulf

In the Gulf, the tide that is propagated from Cabot and Belle Isle straits is mixed but mostly semi-diurnal in character. The circulational pivot of the tide waves is found at the southwestern tip of the Îles de la Madeleine, where the tide is exclusively diurnal. The semi-diurnal tide waves that enter by Cabot Strait circle around the Îles de la Madeleine and extend around the Gulf counter-clockwise. The semi-diurnal tide grows as it makes its way toward the Gulf's perimeter. In the Cabot Strait, the high tide coincides with the low tide of the St. Lawrence Estuary. A much weaker semi-diurnal wave enters the Gulf through the Strait of Belle Isle and extends along the north shore heading toward the St. Lawrence River.

The Estuary and the Fluvial Section

The tidal curve of the St. Lawrence is distinguished by its narrow, sloping riverbed, as well as the increased friction, particularly upstream of Quebec City.

Tidal amplitude grows steadily, reaching 3 m at Pointe-au-Père. As is the case in many estuaries, the speeds of the high and low tides differ as they progress upstream, the low tide travelling more slowly. As such, the low tide takes an average of 12.5 h to extend from Rivière-au-Renard to Trois-Rivières, whereas the high tide takes no more than nine hours, on average, to travel the same route.(1)

The tide progresses in an upstream direction in the River, where its influence is evident until Lake Saint-Pierre. From Sept-Îles, the tide wave takes about one hour to travel to the mouth of the Saguenay River, 5 h to reach Quebec City, and 10 h to penetrate Lake Saint-Pierre.

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The St. Lawrence River – Overview of the Freshwater Fishery in 1994

ROUGHLY 2% OF THE FISH HARVESTED COMMERCIALLY in the St. Lawrence River is fished in the freshwater river corridor; the rest come from the Estuary and particularly the Gulf. In 1994, four species comprised 84% of the freshwater catch in the St. Lawrence: the Brown bullhead (32%), the Yellow perch (25%), the Lake sturgeon (18%) and the American eel (9%).

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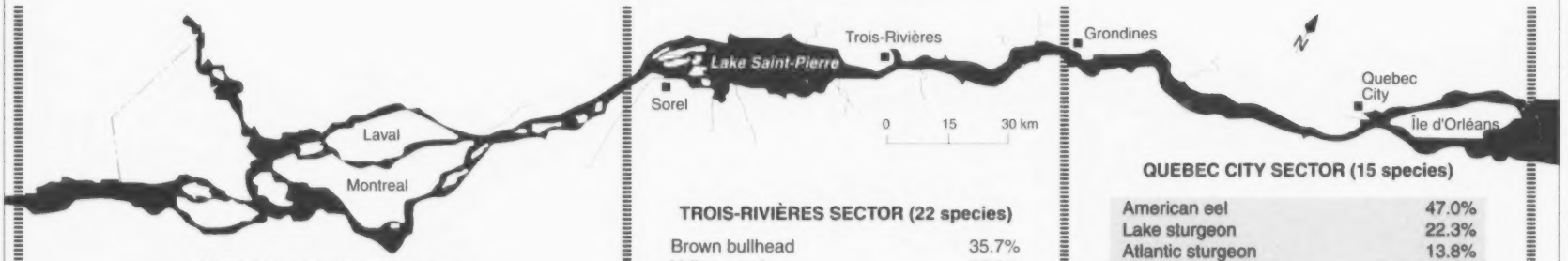
CHARACTERISTICS OF THE FISH HARVEST, BY SECTOR, IN 1994

Region under study	Total catch (tonnes)	Active fishers (number)
Montreal sector	67	11
Trois-Rivières sector	1103	72
Quebec City sector	65	15
River corridor total	**1235**	**98**

MAIN FISH SPECIES CAUGHT, BY SECTOR, IN 1994



MONTREAL SECTOR (7 species)

Lake sturgeon	**80.3%**
Brown bullhead	8.3%
American eel	**7.9%**
Common carp	1.6%
Other species (Channel catfish, White sucker, sunfish)	1.9%

TROIS-RIVIÈRES SECTOR (22 species)

Brown bullhead	35.7%
Yellow perch	27.6%
Lake sturgeon	**13.8%**
Sunfish	7.9%
American eel	**7.0%**
Other species (White sucker, Common carp, crawfish, **American shad, Atlantic tomcod**)	8.0%

QUEBEC CITY SECTOR (15 species)

American eel	**47.0%**
Lake sturgeon	**22.3%**
Atlantic sturgeon	**13.8%**
Sauger and Walleye	5.7%
Brown bullhead	3.4%
Other species (Channel catfish, Yellow perch, sunfish, Whitefish, White sucker)	7.8%

Species which may be at risk within the study area.

POSSIBLE FACTORS ACCOUNTING FOR THE DECLINE OF AT-RISK SPECIES

Species	Possible factors for decline
Lake sturgeon American shad	Changes to habitats due to the construction of dams around the Montreal archipelago, making circulation and access to spawning grounds more difficult. Overfishing of certain populations of Lake sturgeon.
Atlantic tomcod Atlantic sturgeon	Changes to habitats due to development on the River and its use for shipping. Heavy fishing of the Atlantic sturgeon between Portneuf and Pointe-au-Platon from 1956 to 1966.
American eel	We lack the knowledge to explain the variations observed over the past 20 years. The biology of the eel remains relatively unknown.

LAKE SAINT-PIERRE IN 1994

Last bastion of freshwater fishery

- 17 species of fish harvested.
- Represent (%) of commercial freshwater catch in the St. Lawrence:
  - Brown bullhead (93%)
  - Sunfish (93%)
  - Yellow perch (86%)
  - White sucker (67%)
  - Lake sturgeon (44%)
  - Crawfish (44%).
- Landings total 903 tonnes.
- 40% of fishers (41 fishers).

Source: • Fisheries and Oceans. 1991. *Identification des poissons d'intérêt economique en situation précaire dans le réseau Saint-Laurent et sélection des espèces pour des interventions immédiates.* Rapp. Tech. Can. Sci. Halieut. Aqua. No. 1810.
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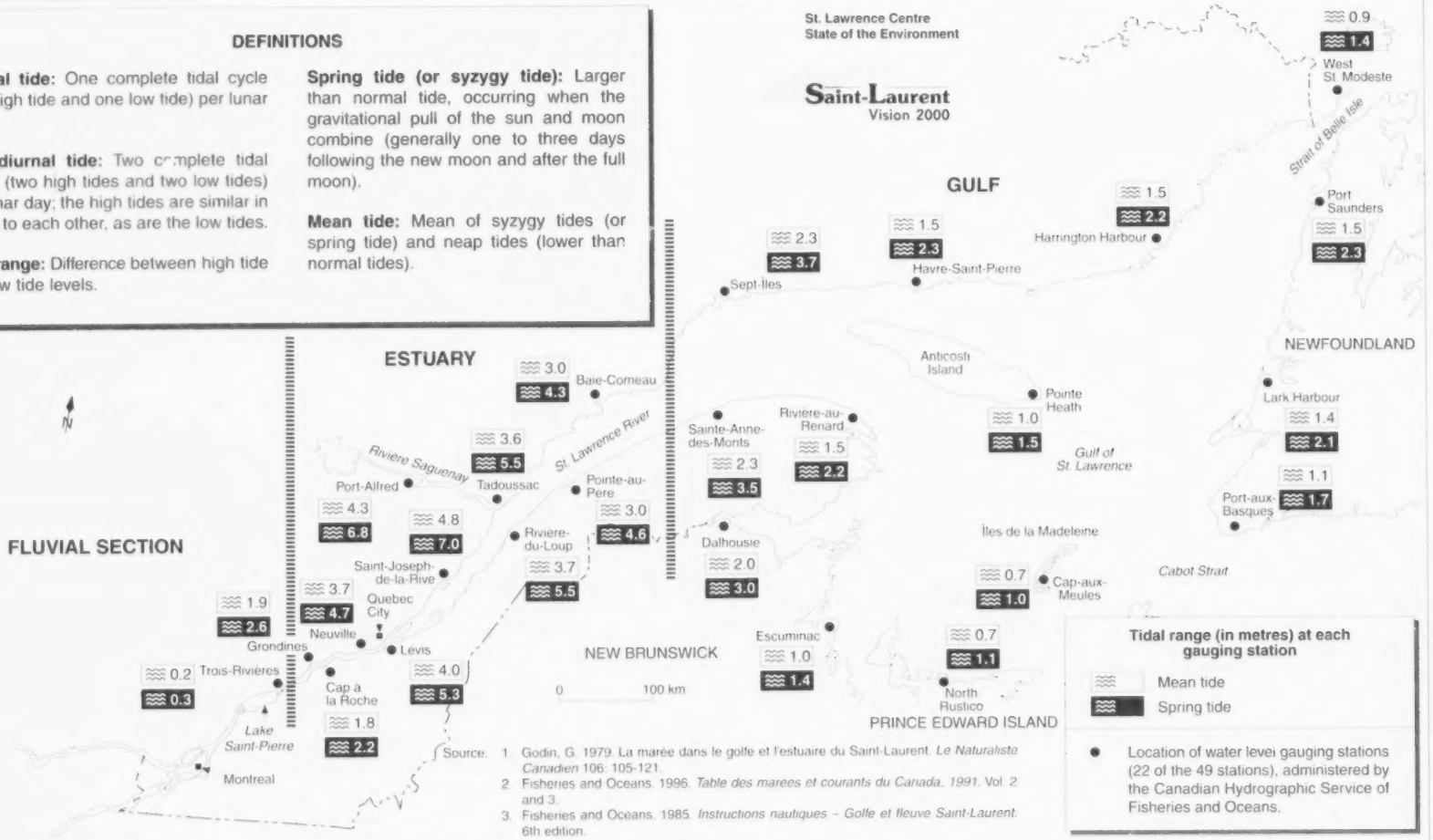

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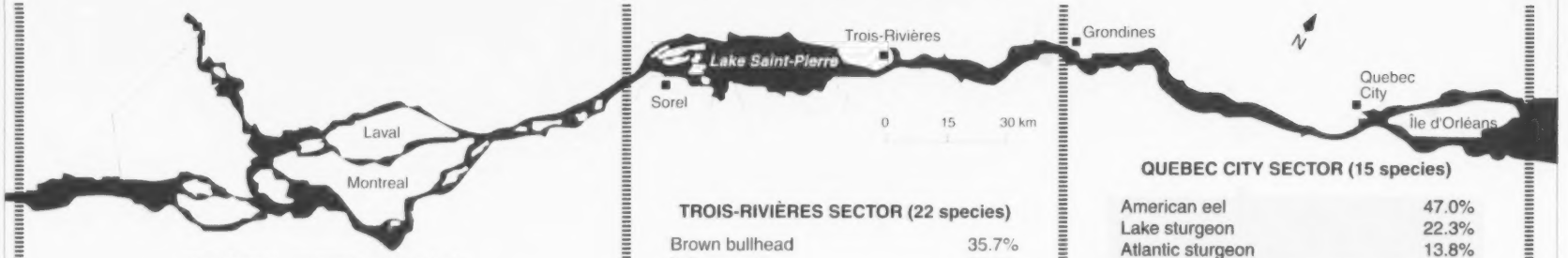

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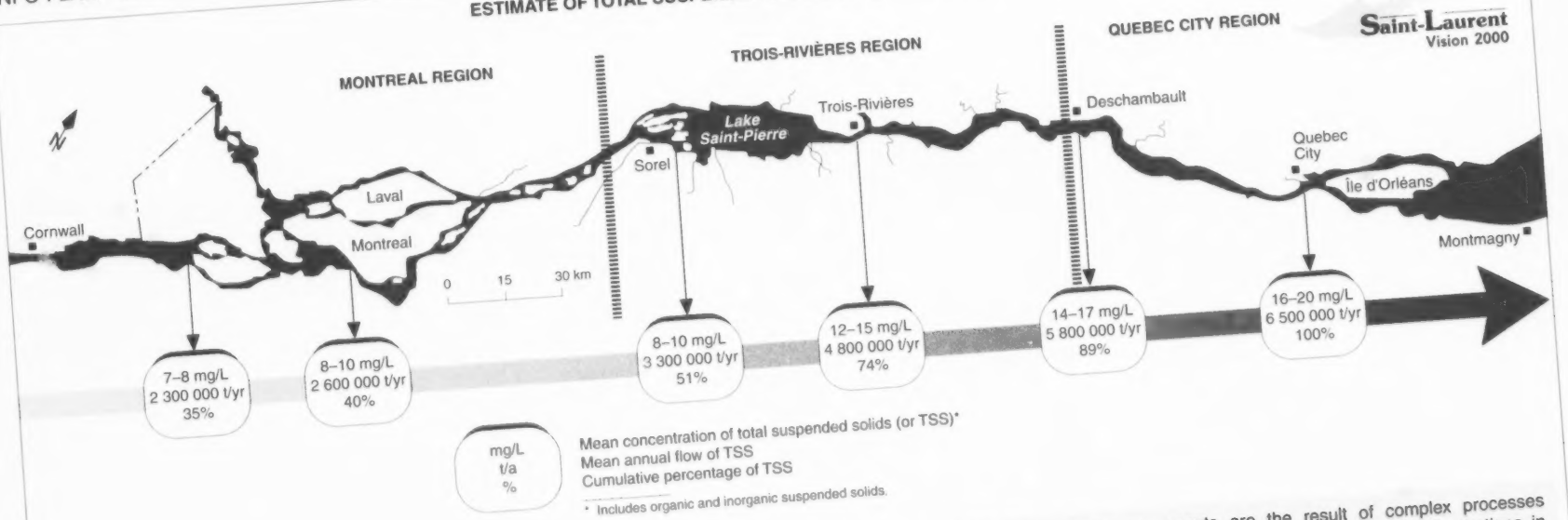
INFO-FLASH 44

The St. Lawrence River – Total Suspended Solids from Cornwall to Quebec City

St. Lawrence Centre
State of the Environment

Saint-Laurent Vision 2000

ESTIMATE OF TOTAL SUSPENDED SOLIDS (long-term average)



Suspended solids are solid particles that float in liquid. They are found in natural waters and are the product of erosion, organic deposition and plankton. Human activities also discharge suspended solids into surface waters.[1]

Fine particles comprise most of the suspended solids that make their way into the St. Lawrence River through the Great Lakes and tributaries. They reach the Upper Estuary (freshwater/saltwater mixing zone), where they may settle temporarily or stay for good.

Their movements are the result of complex processes associated with littoral transport, seasonal fluctuations in flow rate, waves, drifting ice and the phenomena of currents and tides.

GEOGRAPHIC DISTRIBUTION OF TSS

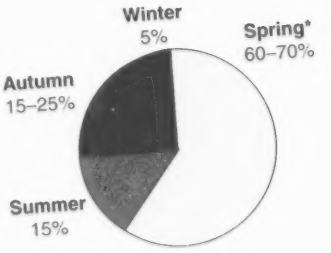
Source of TSS	Mean annual flow of TSS (t/yr)	% of TSS observed at Quebec City
Great Lakes	500 000	8
International section	300 to 500 000	8
Inputs of the Ottawa River	540 000	8
St. Lawrence tributaries	4 500 000	69
Urban and industrial effluents	240 000	4
Bottom transport (post-dredging) downstream of Lake Saint-Pierre	200 000	3
Total (rounded off)	**6 500 000**	**100**

Note: The mean annual flow of TSS originating from sediment resuspension cannot be clearly determined.

ST. LAWRENCE TRIBUTARIES
TSS distribution, by region (%)

Region	North shore	South shore	Total
Montreal	18	10	**28**
Trois-Rivières	20	37	**57**
Quebec City	4	11	**15**
Total	**42**	**58**	**100**

SEASONAL DISTRIBUTION OF TOTAL SUSPENDED SOLIDS



* Especially during spring freshet in April and May.

Source:
1. *Dictionnaire usuel de l'environnement et de l'écologie*. 1982. Guy Le Prat édition, Paris.
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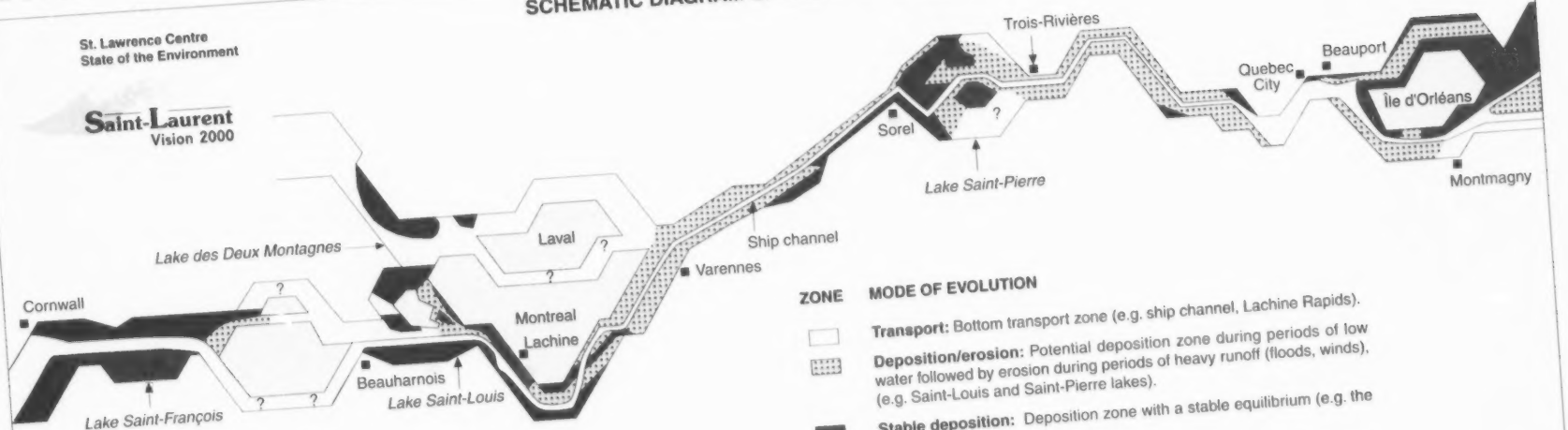
INFO-FLASH 45

The St. Lawrence River – Sediment Dynamics from Cornwall to Montmagny

St. Lawrence Centre
State of the Environment

Saint-Laurent Vision 2000

SCHEMATIC DIAGRAM OF SEDIMENT DYNAMICS



ZONE	MODE OF EVOLUTION
	Transport: Bottom transport zone (e.g. ship channel, Lachine Rapids).
	Deposition/erosion: Potential deposition zone during periods of low water followed by erosion during periods of heavy runoff (floods, winds), (e.g. Saint-Louis and Saint-Pierre lakes).
	Stable deposition: Deposition zone with a stable equilibrium (e.g. the Beauport flats).
	Deposition/accumulation: Deposition zone in a state of growth (e.g. Sorel delta, Contrecoeur).
?	**Undetermined**

SEDIMENT IS DEFINED AS A "DEPOSIT OF DETRITAL, CHEMICAL OR ORGANIC ORIGIN, which results from changes to rocks, the precipitation of dissolved or suspended matter in water, or the continental or marine accumulation of organic matter" (translation).[2]

Sediment dynamics—that is, erosion, transport, accumulation—is important for many reasons:

- **Quality of aquatic life and habitats**

  Sediment dynamics interact with other factors in the relationships between aquatic organisms (mainly benthos) and the environments that support them.

- **Formation of zones of pollutant accumulation**

  Pollutants adhere to solids and thus tend to accumulate in zones of high sediment deposition, which are especially abundant in areas of low current velocity.

- **Human activities and infrastructure**

  The dynamic relationship between the contaminants associated with sediments can affect water and beach quality during water/solid exchanges. Changes in flow conditions caused by human development projects influence the sediment regime, thus making dredging necessary.

EVOLUTION IN SEDIMENT DYNAMICS

Generally speaking, sediment evolves differently as it moves from mid-river to the shore. For example, the centre of the river is a sediment transport zone, whereas the areas nearer to shore are characterized by zones of deposition and accumulation; intermediary zones may be distinguished by the interplay of deposition/erosion (seasonal or annual) or even by stable deposition.[1]

MAIN AGENTS RESPONSIBLE FOR THE RIVER'S COMPLEX SEDIMENT DYNAMICS

- Velocity of main currents
- Seasonal fluctuations in flow rate
- Tides
- Winds
- Ice
- Bathymetry
- Alternating lakes and rapids
- Presence of flats and islands
- Presence of aquatic plants
- Infrastructures (dams, wharfs, marinas, etc.)
- Shore erosion (source of sediments)

Note: The St. Lawrence Centre has studied sediment deposition in the fluvial lakes (Saint-François, Saint-Louis and Saint-Pierre). The results appear in Info-Flash fact sheet 69.

Source: 1. Hydrotech Inc. 1989. *Aspects quantitatifs, dynamiques et qualitatifs des sédiments du Saint-Laurent.* For Environment Canada and the Ministère de l'Environnement du Québec.
2. Parent, S. 1990. *Dictionnaire des sciences de l'environnement.* Éditions Broquet Inc.

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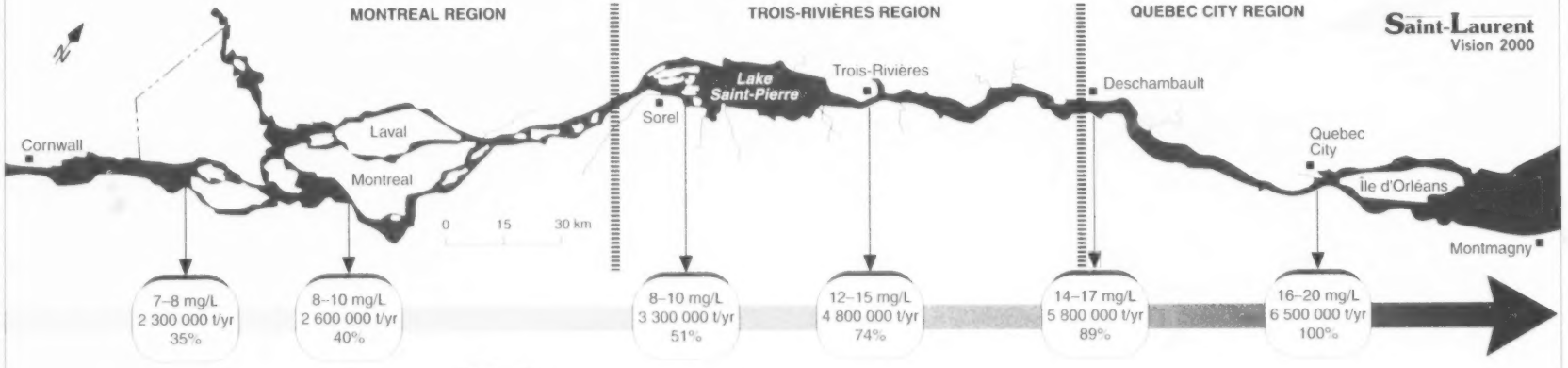

mg/L — Mean concentration of total suspended solids (or TSS)*
t/a — Mean annual flow of TSS
% — Cumulative percentage of TSS

* Includes organic and inorganic suspended solids.

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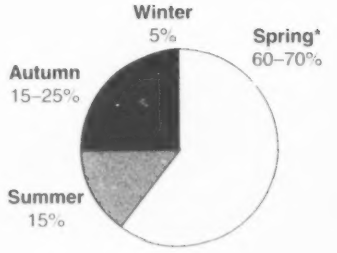

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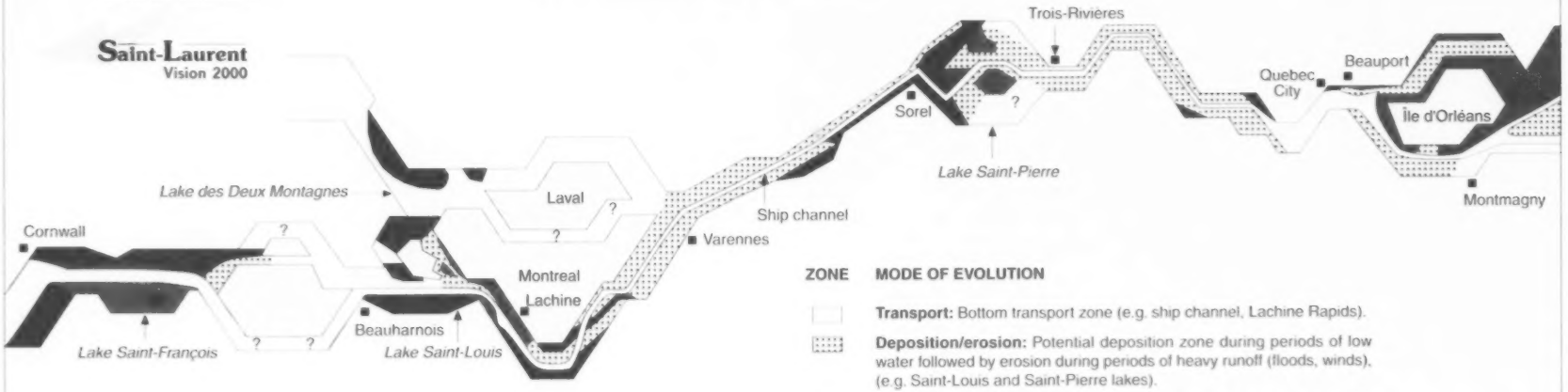

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  Sediment dynamics interact with other factors in the relationships between aquatic organisms (mainly benthos) and the environments that support them.

- **Formation of zones of pollutant accumulation**

  Pollutants adhere to solids and thus tend to accumulate in zones of high sediment deposition, which are especially abundant in areas of low current velocity.

- **Human activities and infrastructure**

  The dynamic relationship between the contaminants associated with sediments can affect water and beach quality during water/solid exchanges. Changes in flow conditions caused by human development projects influence the sediment regime, thus making dredging necessary.

Note: The St. Lawrence Centre has studied sediment deposition in the fluvial lakes (Saint-François, Saint-Louis and Saint-Pierre). The results appear in Info-Flash fact sheet 69.

EVOLUTION IN SEDIMENT DYNAMICS

Generally speaking, sediment evolves differently as it moves from mid-river to the shore. For example, the centre of the river is a sediment transport zone, whereas the areas nearer to shore are characterized by zones of deposition and accumulation; intermediary zones may be distinguished by the interplay of deposition/erosion (seasonal or annual) or even by stable deposition.[1]

MAIN AGENTS RESPONSIBLE FOR THE RIVER'S COMPLEX SEDIMENT DYNAMICS

- Velocity of main currents
- Seasonal fluctuations in flow rate
- Tides
- Winds
- Ice
- Bathymetry
- Alternating lakes and rapids
- Presence of flats and islands
- Presence of aquatic plants
- Infrastructures (dams, wharfs, marinas, etc.)
- Shore erosion (source of sediments)

Source: 1. Hydrotech Inc. 1989. *Aspects quantitatifs, dynamiques et qualitatifs des sediments du Saint-Laurent*. For Environment Canada and the Ministère de l'Environnement du Québec.
2. Parent, S. 1990. *Dictionnaire des sciences de l'environnement*. Editions Broquet Inc.

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March 1997

The St. Lawrence River and Ocean Dumping from 1976 to 1995

St. Lawrence Centre
State of the Environment

Saint-Laurent Vision 2000

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA)

Since 1987, ocean dumping activities have been subject to CEPA (chap. 22, part VI), which is regulated by Environment Canada. Ocean dumping, according to CEPA, is "the deliberate disposal at sea from ships, aircraft, platforms or other anthropogenic structures, including disposal by incineration or other thermal degradation, of any substance, or the disposal of any substance by placing it on the ice in any area of the sea...". The disposal of waste at sea in Canadian territorial waters is regulated by a system of permits administered by the Environmental Protection Branch of Environment Canada.(1)

Factors which must be considered in granting an ocean dumping permit are related to:

- The characteristics and composition of the substances to be dumped.
- The characteristics of the dumping site and disposal method.
- The potential effects on marine plant and animal life and on the sea's other uses.
- The availability of alternative waste treatment or disposal methods.

OCEAN DUMPING ADVISORY COMMITTEE

This scientific committee brings together experts from Environment Canada (Environmental Protection Branch) and Fisheries and Oceans. The committee evaluates ocean dumping activities and makes recommendations to the regional director of Environmental Protection, the body which grants dumping permits.

Committee mandates

- To evaluate ocean dumping proposals from private and government agencies in the region.
- To clarify the terms and conditions for granting permits in compliance with the *Canadian Environmental Protection Act*.
- To determine scientific research and technical requirements.
- To establish a monitoring program for this activity at sea.

WASTE DUMPED AT SEA

ALMOST ALL WASTE DUMPED INTO THE ST. LAWRENCE RIVER (downstream of Anticosti Island) consists of dredged material from the routine dredging of ports and shipping channels. This sediment is comprised mostly of sand or silt that is harmless to the environment. Ocean dumping is permitted only for non-hazardous wastes and when it is the least harmful environmental option.

OCEAN DUMPING FROM 1976 TO 1995

All permits issued were for ocean dumping of dredged material, excavation materials, and non-recyclable fish waste.

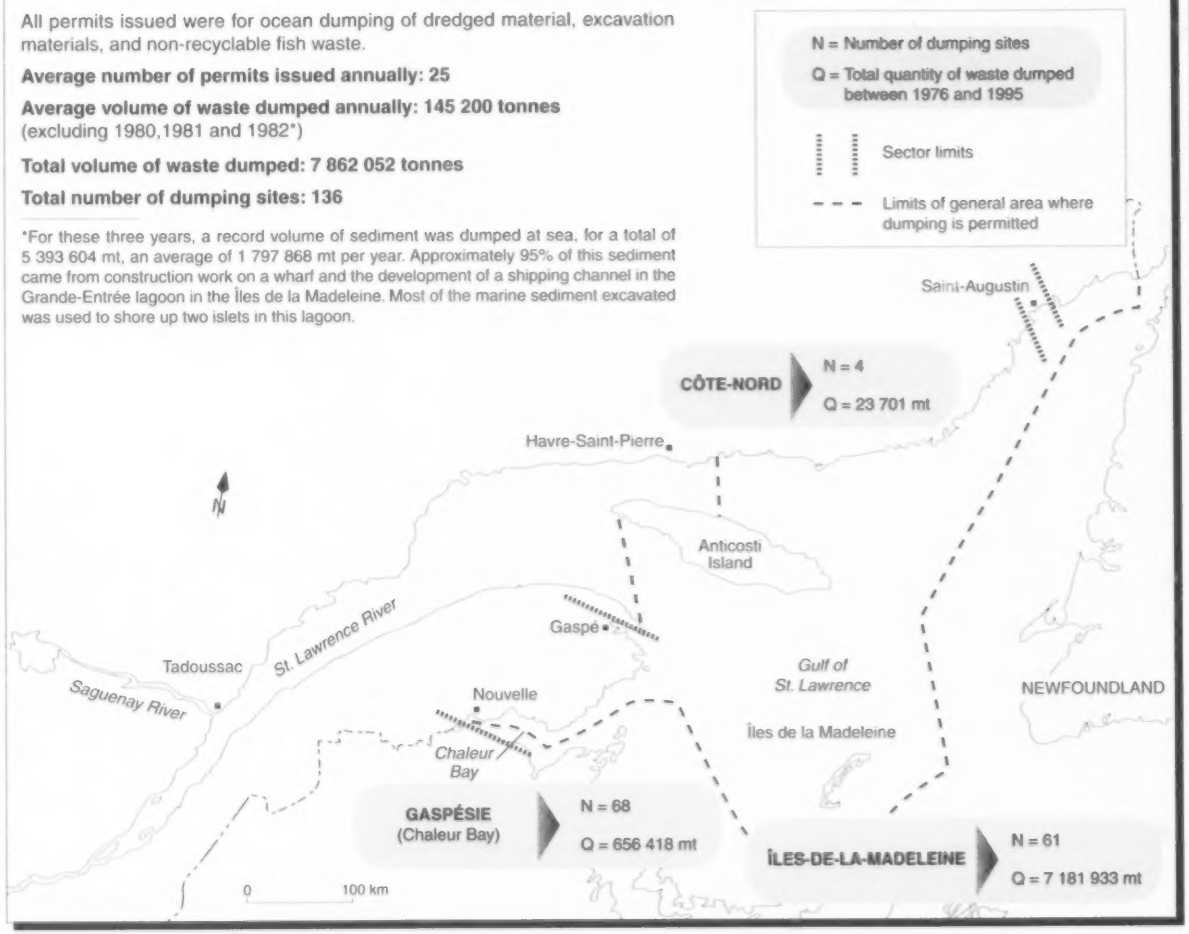
Average number of permits issued annually: 25

Average volume of waste dumped annually: 145 200 tonnes (excluding 1980,1981 and 1982*)

Total volume of waste dumped: 7 862 052 tonnes

Total number of dumping sites: 136

*For these three years, a record volume of sediment was dumped at sea, for a total of 5 393 604 mt, an average of 1 797 868 mt per year. Approximately 95% of this sediment came from construction work on a wharf and the development of a shipping channel in the Grande-Entrée lagoon in the Îles de la Madeleine. Most of the marine sediment excavated was used to shore up two islets in this lagoon.



Source:
- *Canadian Environmental Protection Act*, ch. 22, part VI, 1988.
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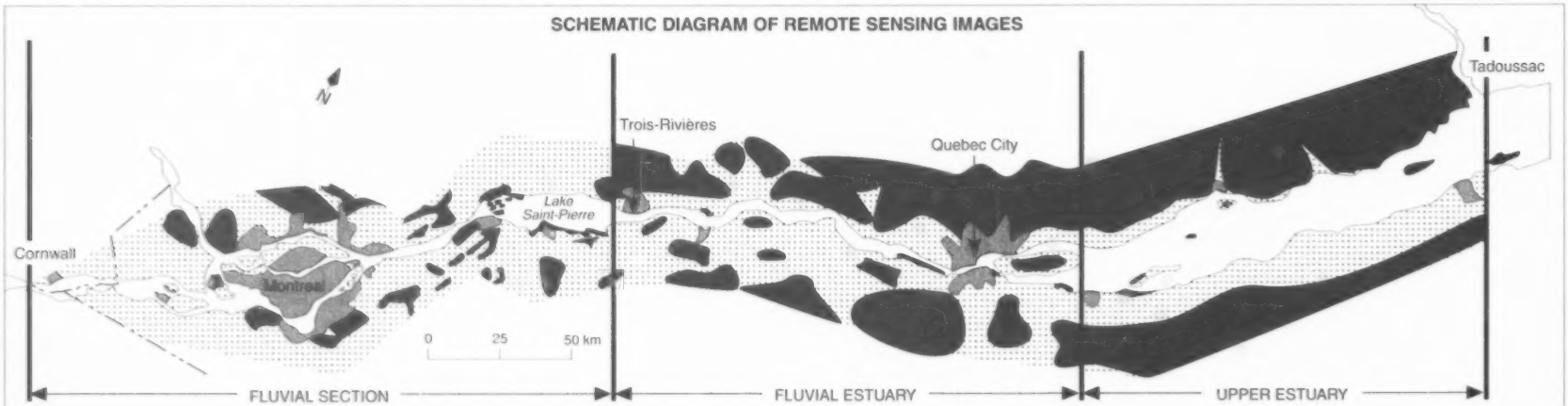
March 1997

The St. Lawrence River – Land Use between Cornwall and Tadoussac (1989)

SCHEMATIC DIAGRAM OF REMOTE SENSING IMAGES



REMOTE SENSING IMAGES were used to represent land use patterns along the 10-km-wide riparian strip between Cornwall and Tadoussac. These images can be used to evaluate the extent of the various land use categories, based on an analysis of the area's physical characteristics:

- wetlands (undistinguished aquatic plant communities, marshes and swamps)
- forests (incl. bogs)
- agricultural areas (forage and annual crops)
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Note that despite their ecological significance, wetlands, particularly those at Cap Tourmente, are not visible on this scale.

AREA OCCUPIED BY THE ST. LAWRENCE

In the Fluvial Section, water occupies 1100 km² because of the presence of Saint-François, Saint-Louis and Saint-Pierre lakes, and the La Prairie Basin. This area decreases to 642 km² in the Fluvial Estuary. Note that in the Upper Estuary, the water reaches a width of 3146 km² due to the marked widening of the St. Lawrence, which goes from 10 km wide downstream of Île d'Orléans to 30 km at Tadoussac.

ESTIMATE OF SURFACE AREA (km²) OCCUPIED, BY LAND USE CATEGORY AND RIVER SECTOR

CATEGORY	FLUVIAL SECTION	FLUVIAL ESTUARY	UPPER ESTUARY	TOTAL km²	TOTAL %
Wetlands	522	196	151	869	5.4
Forests					
• hardwood	638	424	359	1 421	
• mixed	462	510	1 261	2 233	
• coniferous	252	1 228	1 309	2 789	
Sub-total	1 352	2 162	2 929	6 443	39.7
Farmland and idle land					
• grassland	1 222	408	180	1 810	
• pasture	577	360	314	1 251	
• grain/corn	1 360	520	231	2 111	
• fallow land	693	763	520	1 976	
Sub-total	3 852	2 051	1 245	7 148	44.1
Built-up areas and bare soil					
• low density	571	273	43	887	
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Sub-total	1 098	540	115	1 753	10.8
Total	6 824	4 949	4 440	16 213	100.0

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Here, the surface area of farmland and idle land is, respectively, two to three times larger than along the Fluvial Estuary and the Upper Estuary. What's more, built-up zones cover a much larger area than they do in other sections of the St. Lawrence River because of the presence of Montreal. Lake Saint-Pierre contains 358 km² of wetlands, or 67% of all wetlands in the Fluvial Section.

Fluvial Estuary

There is a marked transition in the pattern of land use in this section of the St. Lawrence. Both the areas given over to agriculture and the built-up areas diminish in favour of forests, most notably coniferous forest, whose surface area here is five times larger than on the shore of the Fluvial Section.

Upper Estuary

The surface area of farmland and built-up areas is decidedly smaller than in other parts of the St. Lawrence. Instead, forests here occupy 2929 km² of land.

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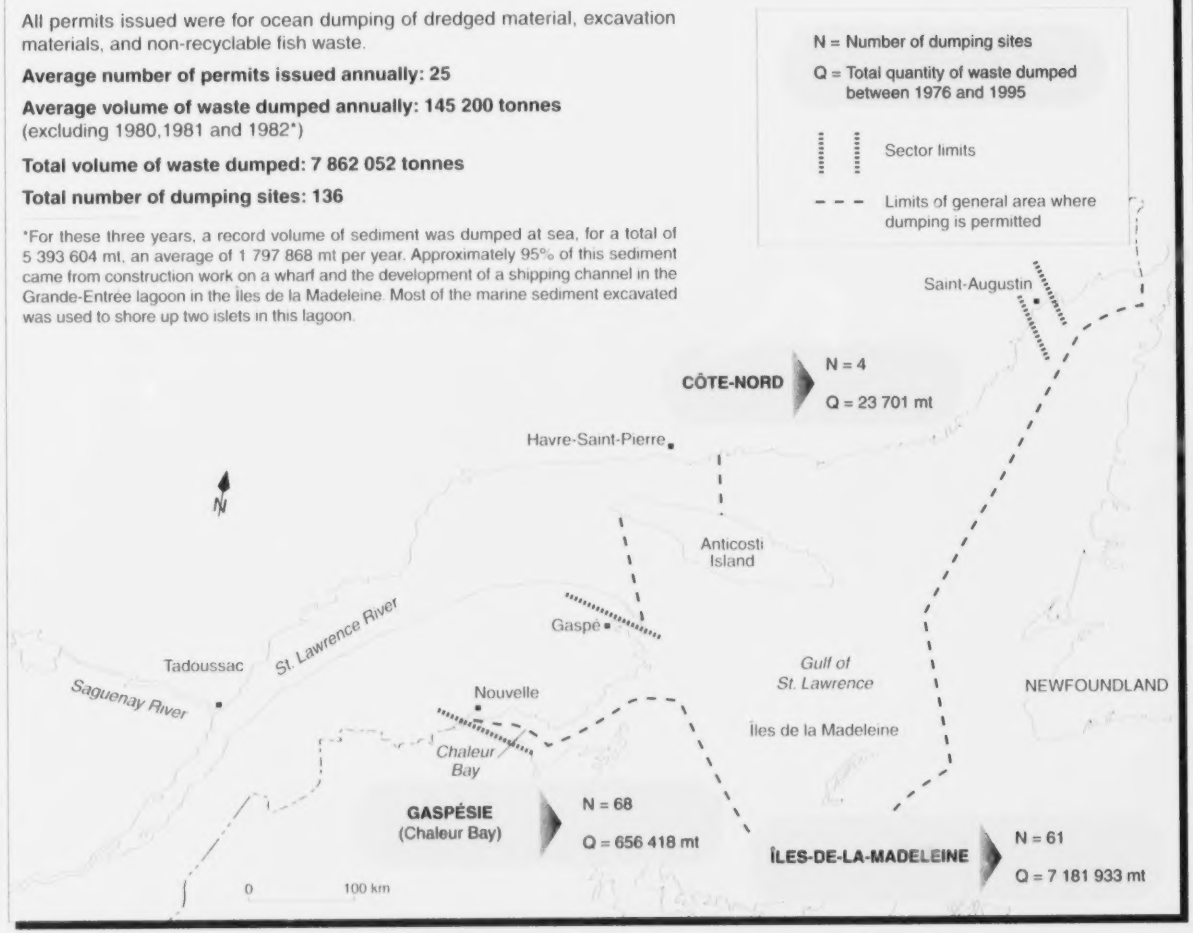

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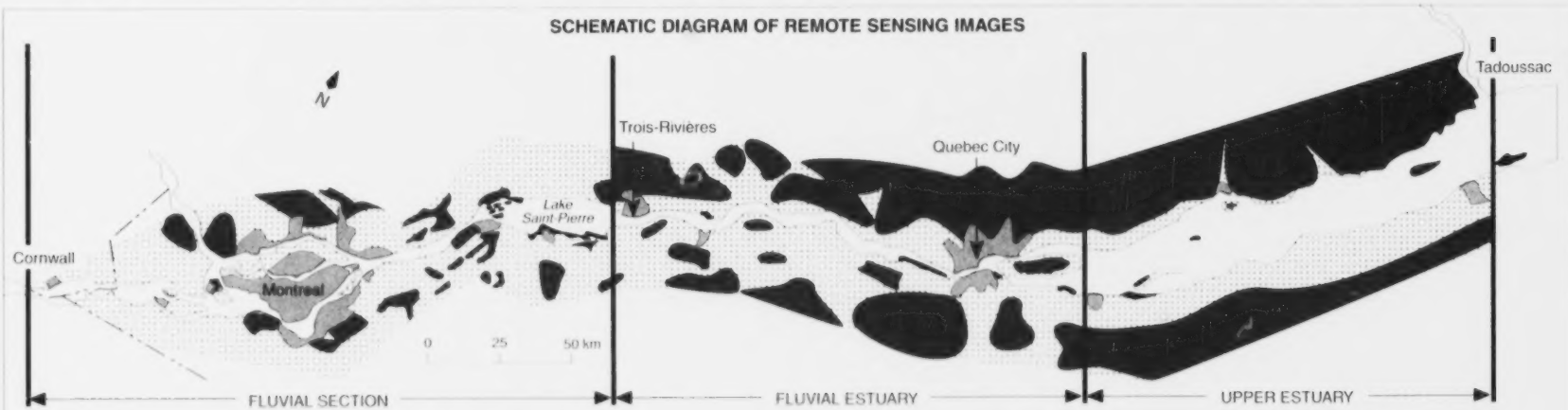

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The St. Lawrence River – Peatlands

DEFINITION AND CHARACTERISTICS OF PEATLANDS

PEATLANDS ARE WETLANDS which develop during periods when the climate and drainage favour the accumulation rather than the decomposition of organic matter. Water circulation is poor and the water table remains close to the soil surface, thereby creating anaerobic (without oxygen) conditions which slow down the activity of decomposer micro-organisms.

There are two types of peatlands:

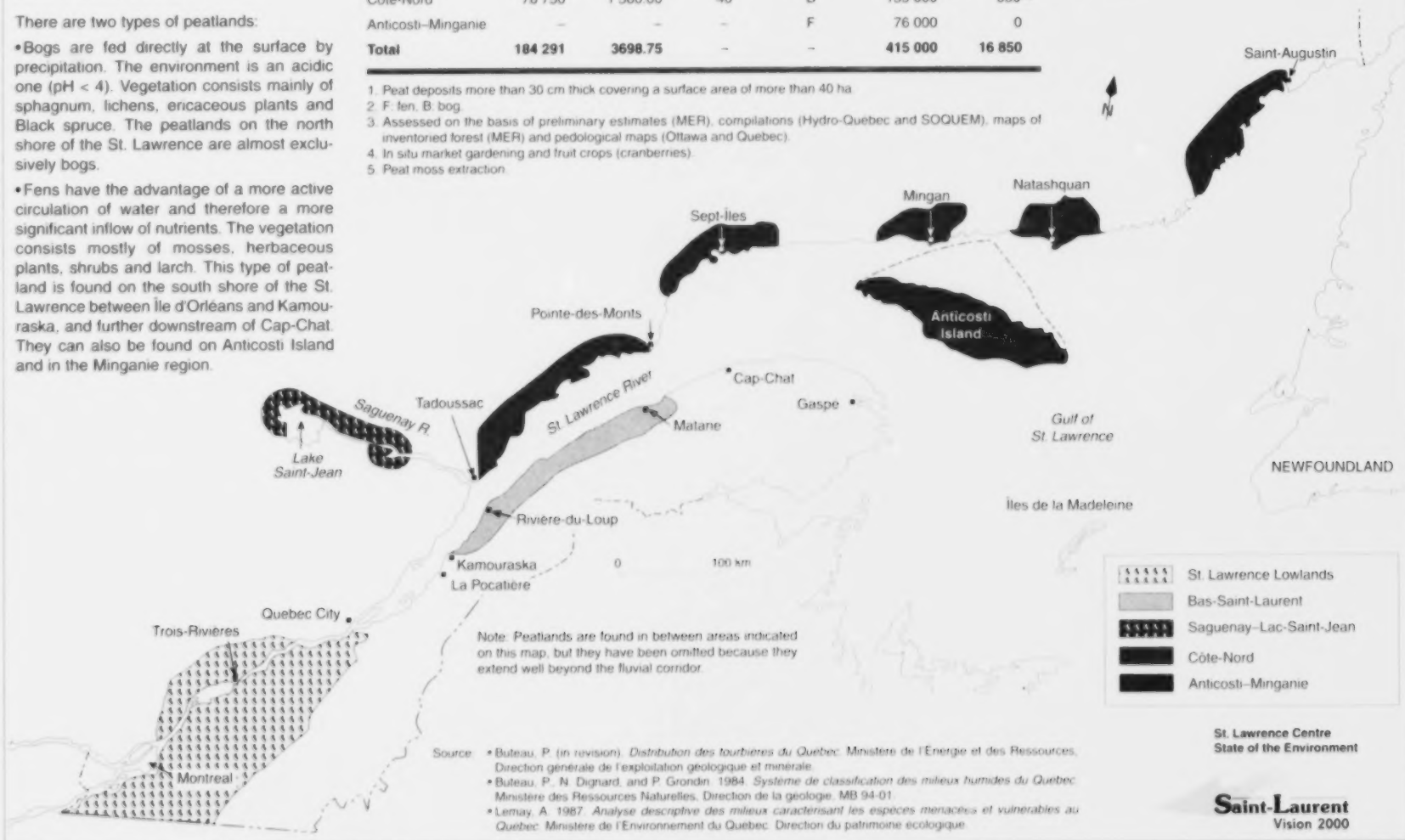
- Bogs are fed directly at the surface by precipitation. The environment is an acidic one (pH < 4). Vegetation consists mainly of sphagnum, lichens, ericaceous plants and Black spruce. The peatlands on the north shore of the St. Lawrence are almost exclusively bogs.
- Fens have the advantage of a more active circulation of water and therefore a more significant inflow of nutrients. The vegetation consists mostly of mosses, herbaceous plants, shrubs and larch. This type of peatland is found on the south shore of the St. Lawrence between Île d'Orléans and Kamouraska, and further downstream of Cap-Chat. They can also be found on Anticosti Island and in the Minganie region.

Region	Resource inventoried[1] (MER) Surface area (ha)	Total volume (x 10^6 m^3)	Fibrous peat (%)	Dominant trophic level[2]	Potential resource[3] (ha)	Surface area used (ha)
St. Lawrence Lowlands	64 521	1241.07	10	B	135 000	12 880[4]
Bas-Saint-Laurent	8 615	206.76	24	B	9 000	3 100[5]
Saguenay–Lac-Saint-Jean	32 405	670.92	13	B	60 000	660
Côte-Nord	78 750	1 580.00	40	B	135 000	530[5]
Anticosti–Minganie	–	–	–	F	76 000	0
Total	**184 291**	**3698.75**	–	–	**415 000**	**16 850**

1. Peat deposits more than 30 cm thick covering a surface area of more than 40 ha.
2. F: fen, B: bog.
3. Assessed on the basis of preliminary estimates (MER), compilations (Hydro-Québec and SOQUEM), maps of inventoried forest (MER) and pedological maps (Ottawa and Quebec).
4. In situ market gardening and fruit crops (cranberries).
5. Peat moss extraction.

CONSUMPTION

In 1996, Quebec was the biggest producer of agricultural peat in Canada. In 1996, 12 600 ha of peatlands were exploited for in situ market gardening and 320 ha in the production of cranberries, 87% of which took place in the St. Lawrence Lowlands. In the Bas-Saint-Laurent, especially between La Pocatière and Rivière-du-Loup, 3100 ha of land was exploited for the extraction of peat moss.



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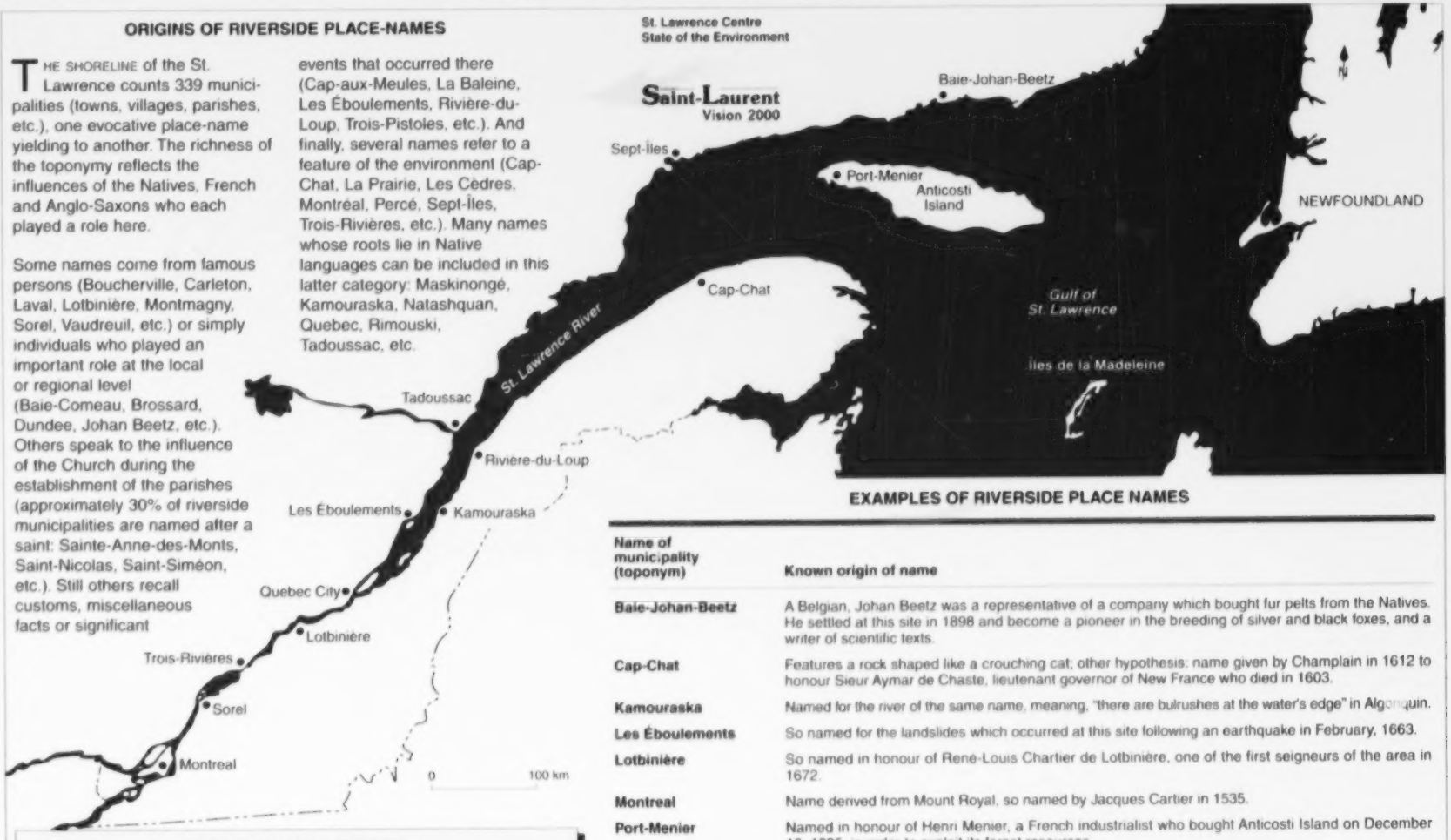
The St. Lawrence River – Toponymy of Riverside Municipalities

ORIGINS OF RIVERSIDE PLACE-NAMES

The shoreline of the St. Lawrence counts 339 municipalities (towns, villages, parishes, etc.), one evocative place-name yielding to another. The richness of the toponymy reflects the influences of the Natives, French and Anglo-Saxons who each played a role here.

Some names come from famous persons (Boucherville, Carleton, Laval, Lotbinière, Montmagny, Sorel, Vaudreuil, etc.) or simply individuals who played an important role at the local or regional level (Baie-Comeau, Brossard, Dundee, Johan Beetz, etc.). Others speak to the influence of the Church during the establishment of the parishes (approximately 30% of riverside municipalities are named after a saint: Sainte-Anne-des-Monts, Saint-Nicolas, Saint-Siméon, etc.). Still others recall customs, miscellaneous facts or significant events that occurred there (Cap-aux-Meules, La Baleine, Les Éboulements, Rivière-du-Loup, Trois-Pistoles, etc.). And finally, several names refer to a feature of the environment (Cap-Chat, La Prairie, Les Cèdres, Montréal, Percé, Sept-Îles, Trois-Rivières, etc.). Many names whose roots lie in Native languages can be included in this latter category: Maskinongé, Kamouraska, Natashquan, Quebec, Rimouski, Tadoussac, etc.



THE ST. LAWRENCE RIVER

Samuel de Champlain adopted this name for the River in the 17th-century accounts of his voyage. It is derived from the name of a bay on the Côte-Nord named Baie Saint-Laurent by Jacques Cartier on August 10, 1535, to honour this saint's feast day.

The miscomprehension of Cartier's narrative by its first two translators (a Spaniard in 1552 and an Italian in 1556) led to their attributing the name of this bay to the gulf and then the whole of the river. "Cartographers and writers of the 16th century increasingly referred to the Spanish and Italian translations of the *Bref Récit* of 1535-1536 rather than to the original French" (translation).[1] The St. Lawrence was also called the "Hochelaga" (Cartier, 1535), and the "Canada River" (Jean Alfonse, pilot, 1544).

EXAMPLES OF RIVERSIDE PLACE NAMES

Name of municipality (toponym)	Known origin of name
Baie-Johan-Beetz	A Belgian, Johan Beetz was a representative of a company which bought fur pelts from the Natives. He settled at this site in 1898 and become a pioneer in the breeding of silver and black foxes, and a writer of scientific texts.
Cap-Chat	Features a rock shaped like a crouching cat; other hypothesis: name given by Champlain in 1612 to honour Sieur Aymar de Chaste, lieutenant governor of New France who died in 1603.
Kamouraska	Named for the river of the same name, meaning, "there are bulrushes at the water's edge" in Algonquin.
Les Éboulements	So named for the landslides which occurred at this site following an earthquake in February, 1663.
Lotbinière	So named in honour of René-Louis Chartier de Lotbinière, one of the first seigneurs of the area in 1672.
Montreal	Name derived from Mount Royal, so named by Jacques Cartier in 1535.
Port-Menier	Named in honour of Henri Menier, a French industrialist who bought Anticosti Island on December 16, 1895, in order to exploit its forest resources.
Quebec	Name derived from Algonquin word meaning "narrowing of the river".
Rivière-du-Loup	Comes from a French vessel, *Le Loup*, which was forced to winter at the river mouth around 1659.
Sept-Îles	Writing in his accounts in 1535, Jacques Cartier refers to an archipelago of seven islands (which he names Îles Rondes) at the inlet of the bay.
Sorel	Comes from Pierre de Saurel, captain in the Carignan-Salières regiment, who was granted this land in 1672.
Tadoussac	Native word meaning "knoll", referring to the rounded and sandy hills which are found at this site.
Trois-Rivières	At this site, the Saint-Maurice River empties into the St. Lawrence through the three main mouths formed by the presence of several small islands.

Source: 1. Commission de Toponymie du Québec. 1984. *Itinéraire toponymique du Saint-Laurent, ses rives et ses îles*. Études et recherches toponymiques, 9.

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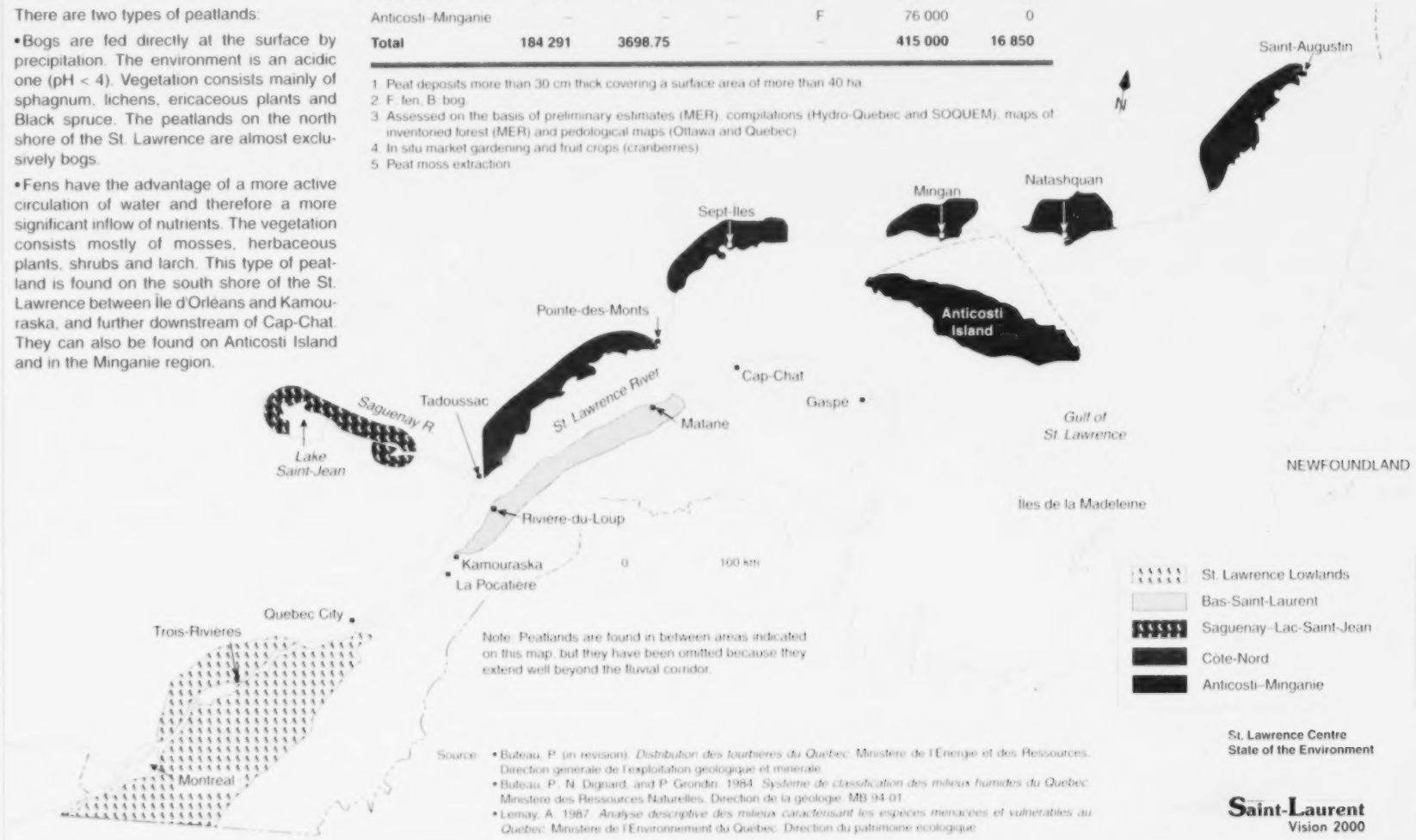

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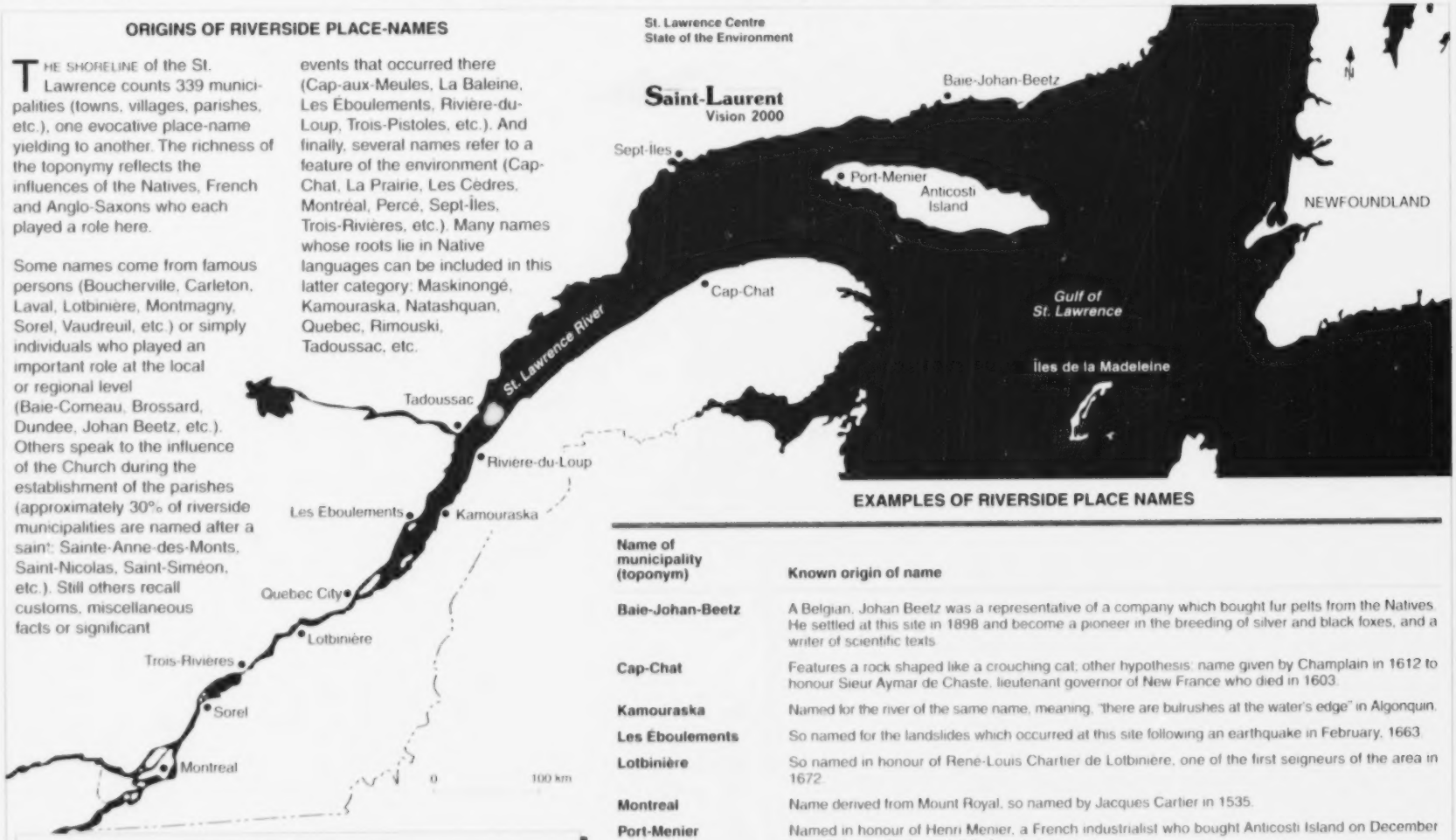
The St. Lawrence River – Toponymy of Riverside Municipalities

ORIGINS OF RIVERSIDE PLACE-NAMES

THE SHORELINE of the St. Lawrence counts 339 municipalities (towns, villages, parishes, etc.), one evocative place-name yielding to another. The richness of the toponymy reflects the influences of the Natives, French and Anglo-Saxons who each played a role here.

Some names come from famous persons (Boucherville, Carleton, Laval, Lotbinière, Montmagny, Sorel, Vaudreuil, etc.) or simply individuals who played an important role at the local or regional level (Baie-Comeau, Brossard, Dundee, Johan Beetz, etc.). Others speak to the influence of the Church during the establishment of the parishes (approximately 30% of riverside municipalities are named after a saint: Sainte-Anne-des-Monts, Saint-Nicolas, Saint-Siméon, etc.). Still others recall customs, miscellaneous facts or significant events that occurred there (Cap-aux-Meules, La Baleine, Les Éboulements, Rivière-du-Loup, Trois-Pistoles, etc.). And finally, several names refer to a feature of the environment (Cap-Chat, La Prairie, Les Cèdres, Montréal, Percé, Sept-Îles, Trois-Rivières, etc.). Many names whose roots lie in Native languages can be included in this latter category: Maskinongé, Kamouraska, Natashquan, Quebec, Rimouski, Tadoussac, etc.



THE ST. LAWRENCE RIVER

Samuel de Champlain adopted this name for the River in the 17th-century accounts of his voyage. It is derived from the name of a bay on the Côte-Nord named Baie Saint-Laurent by Jacques Cartier on August 10, 1535, to honour this saint's feast day.

The miscomprehension of Cartier's narrative by its first two translators (a Spaniard in 1552 and an Italian in 1556) led to their attributing the name of this bay to the gulf and then the whole of the river. "Cartographers and writers of the 16th century increasingly referred to the Spanish and Italian translations of the *Bref Récit* of 1535-1536 rather than to the original French" (translation).[1] The St. Lawrence was also called the "Hochelaga" (Cartier, 1535), and the "Canada River" (Jean Alfonse, pilot, 1544).

EXAMPLES OF RIVERSIDE PLACE NAMES

Name of municipality (toponym)	Known origin of name
Baie-Johan-Beetz	A Belgian, Johan Beetz was a representative of a company which bought fur pelts from the Natives. He settled at this site in 1898 and become a pioneer in the breeding of silver and black foxes, and a writer of scientific texts.
Cap-Chat	Features a rock shaped like a crouching cat; other hypothesis: name given by Champlain in 1612 to honour Sieur Aymar de Chaste, lieutenant governor of New France who died in 1603.
Kamouraska	Named for the river of the same name, meaning, "there are bulrushes at the water's edge" in Algonquin.
Les Éboulements	So named for the landslides which occurred at this site following an earthquake in February, 1663.
Lotbinière	So named in honour of René-Louis Chartier de Lotbinière, one of the first seigneurs of the area in 1672.
Montreal	Name derived from Mount Royal, so named by Jacques Cartier in 1535.
Port-Menier	Named in honour of Henri Menier, a French industrialist who bought Anticosti Island on December 16, 1895, in order to exploit its forest resources.
Quebec	Name derived from Algonquin word meaning "narrowing of the river".
Rivière-du-Loup	Comes from a French vessel, *Le Loup*, which was forced to winter at the river mouth around 1659.
Sept-Îles	Writing in his accounts in 1535, Jacques Cartier refers to an archipelago of seven islands (which he names Îles Rondes) at the inlet of the bay.
Sorel	Comes from Pierre de Saurel, captain in the Carignan-Salieres regiment, who was granted this land in 1672.
Tadoussac	Native word meaning "knoll", referring to the rounded and sandy hills which are found at this site.
Trois-Rivières	At this site, the Saint-Maurice River empties into the St. Lawrence through the three main mouths formed by the presence of several small islands.

Source: 1. Commission de Toponyme du Québec. 1984. *Itinéraire toponymique du Saint-Laurent, ses rives et ses îles*. Études et recherches toponymiques, 9.

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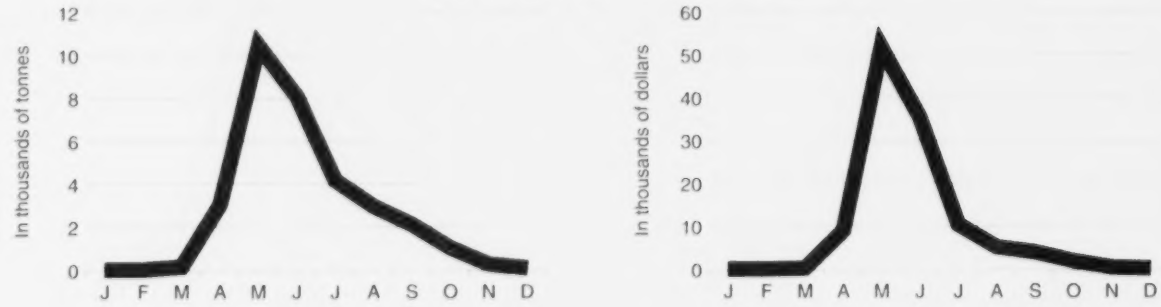
March 1997

The St. Lawrence River – Edible Molluscs and Crustaceans

MOLLUSCS AND CRUSTACEANS are aquatic invertebrates whose soft bodies are generally protected by a shell or carapace. Included in this category are mussels and clams with a hard outer shell, as well as the squid, which has a horny internal shell. Lobsters and crabs belong to the class Crustacea. They have a hard, articulated and flexible carapace. The saltwater species shown here have significant economic value because they are sought for human consumption.

MONTHLY CHANGES IN MOLLUSC AND CRUSTACEAN LANDINGS IN QUEBEC IN 1994 (MINUS DISCARDS)

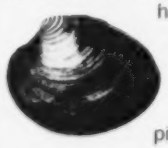


In 1994, molluscs and crustaceans represented $118 million, or 91%, of the $130 million total value of landings in Quebec.

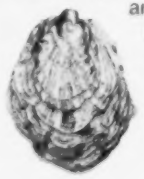
MOLLUSCS

Soft-shell clam *(Mya arenaria):* Measuring an average of 5 cm, Soft-shell clams live in sandy or muddy sediment. They can be dug up with a hydraulic dredge, but most fishers use a hoe or clam fork.

Hardshell clam *(Mercenaria mercenaria):* By the time it has finished growing, the clam can reach 13 cm. With a hard and thick shell, this bottom-dweller lives in sandy and muddy conditions. People generally gather clams at low tide using a pitchfork or simply their hands.



Atlantic oyster *(Crassostrea virginica):* Both the shape and the quality of the oyster is determined by its surrounding environment. On soft sea bottoms it adopts a long and narrow shape, whereas on hard bottoms it becomes round and concave. Oysters are harvested with the help of a rake.



Sea scallop *(Placopecten magellanicus* and *Chlamys islandica):* Scallops come in two varieties, the Giant or deep sea scallop, some 12 cm in diameter, and the Iceland scallop, which lives in fresher and deeper waters. They are found on gravel or rocks on the sea floor. Fishers use boats equipped with large-meshed wire dragnets to gather them.

Blue mussel *(Mytilus edulis):* Measuring between 3 and 8 cm, the shell of the Blue mussel is lightweight and blue-black in colour. It is commonly found attached by its filaments to rocks, wharfs and pilings.

Waved whelk *(Buccinum undatum):* Measuring approximately 6 cm, whelks are found on all types of sea bottoms at depths of up to 30 m. They are caught with baited traps.

Shortfin squid *(Illex illecebrosus):* A mollusc with an internalized shell, the squid's soft, muscular body is some 30 cm long. Most of the catch is exported, dried squid having opened up new markets in the Far East.

CRUSTACEANS

American lobster *(Homarus americanus):* They live on rocky sea bottoms all along the east coast of North America. Lobsters are between 18 and 30 cm long and weigh from 0.23 to 0.91 kg, although they can weigh more than 20 kg. Although mainly scavengers, lobsters supplement their diet with fish. In Quebec, they are caught in lobster pots baited with dead fish.

Pink shrimp *(Pandalus borealis):* Shrimp of a saleable size live at depths of 185 to 300 m, close to the clay sea bottoms that are rich in organic carbon. It is presumed that, during the day, they remain at less than 5 m from the bottom, whereas they climb the water column at night. Shrimp fishing takes place mostly in the northern part of the Gulf of St. Lawrence.

Atlantic snowcrab *(Chionoecetes opilio):* At full maturity, males are twice as large as females, measuring 13 cm around and weighing 0.7 kg. This crustacean is found on muddy or sandy sea bottoms, at a depth of 70 to 140 m. As a population management measure, only males are harvested.

St. Lawrence Centre
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Source • Fisheries and Oceans. 1995. *Les pêches maritimes du Québec, revue statistique annuelle 1993-1994.*
• Fisheries and Oceans. 1989. *Atlantic Shellfish.* Fact sheet in the "Underwater World" series.

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March 1997

The St. Lawrence River – Edible Molluscs and Crustaceans

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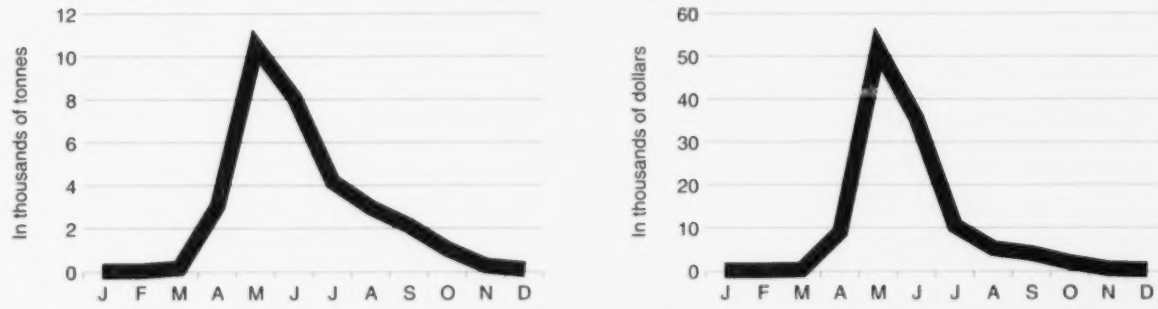

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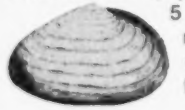

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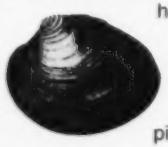

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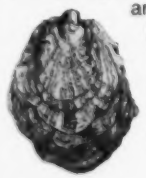

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March 1997

INFO-FLASH 51

The St. Lawrence River and Types of Pollution

	Organic	Contaminants*	Biogenic (by fertilizers)	Microbial	Visual or Aesthetic	Thermal
Associated Pollutants	• Organic matter (BOD)	• Organic: - resin acids, fatty acids - oils and greases - pesticides - organochlorine substances - PAHs, PCBs, phenols, benzenes, toluenes, dioxins, furans, etc. • Inorganic: - heavy metals (e.g. As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn, etc.) - cyanide, sulphate, sulphur	• Nutritive substances, nutrients: - nitrogen - phosphorus	• Bacteria and viruses: - fecal coliforms - streptococcus - enterococcus - *Escherichia coli* - *Pseudomonas aeruginosa* - *Giardia lambia*	• Dyes (colour) • Odours • Suspended solids (turbidity) • Floating objects, debris, oily matter • Algae	• Hot water
Sources	• Human-, animal- and industrial-source organic waste from agri-food plants, pulp and paper mills and municipalities	• Discharge of organic substances by agricultural, petroleum and chemical plants, pulp and paper mills, etc. • Discharge of inorganic substances by chemical, metallurgical, mining and surface treatment plants	• Domestic and agricultural wastes • Discharge of nitrogen products by manufacturers of explosives and fertilizers	• Human- and animal-source wastes lead to the appearance of pathogenic organisms in water	• Pulp and paper mills, petroleum and textile plants • Discharges of untreated municipal wastewater • Farming activities	• Discharges of water used in industrial cooling processes
Environmental Impacts	• Reduced oxygen content in water leads to the disappearance of some fish species • Noxious odours • Nutrient enrichment of water (nitrogen, phosphorus) causes the proliferation of aquatic vegetation	• Immediate or latent effects (can accumulate slowly in tissue and progressively act on living organisms) • Depending on the nature of the substance, the amount discharged and the species concerned, animal and plant species may be destroyed, thereby weakening a link in the food chain • Phenomenon of biomagnification may affect human beings	• Proliferation of algae and aquatic plants along the shorelines of farming regions. The decomposition of these plants leads to a reduced oxygen content in water and creates an unfavourable environment for aquatic wildlife • Can lead to a deterioration of the aesthetic quality of water bodies	• Creation of an environment favourable to the propagation of some infectious diseases: - Necessitates the treatment of water intended for consumption - Interferes with some recreational activities - Leads to the closing of shellfish areas	• Makes the practice of some recreational activities unappealing • Some types of aesthetic pollution, such as suspended solids, can destroy spawning grounds	• Artificial warming of ecosystems located in the area of discharge points
Areas Most Affected	• Rivers located in the farm belt of the St. Lawrence Valley • Bays and lakes that receive urban effluent and wastes from agri-food plants and pulp and paper mills	• Mining regions • Rivers crossing areas of intensive farming • Sites of major industrial discharges • Rivers subject to the combined effects of industrial and farm wastes	• South shore of the St. Lawrence, especially at the mouths of the River's largest tributaries	• Discharge points for sewer water of isolated dwellings and municipalities • Intensive animal farming areas	• Urban regions in proximity of discharge points for many industries and municipalities • Rivers crossing areas of intensive farming	• Wastewater discharge points for certain industries using cooling processes (e.g. nuclear power stations, metallurgical plants)

* Some contaminants are toxic, especially PCBs, heavy metals, dioxins and furans.

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Source: • Government of Canada. 1991. *The State of Canada's Environment*.
• Various publications of the Ministère de l'Environnement du Québec.

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March 1997

The St. Lawrence River – Relative Importance of PAHs (1990–91)

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PAH LOADS AND CONCENTRATIONS IN THE RIVER (1990-91)

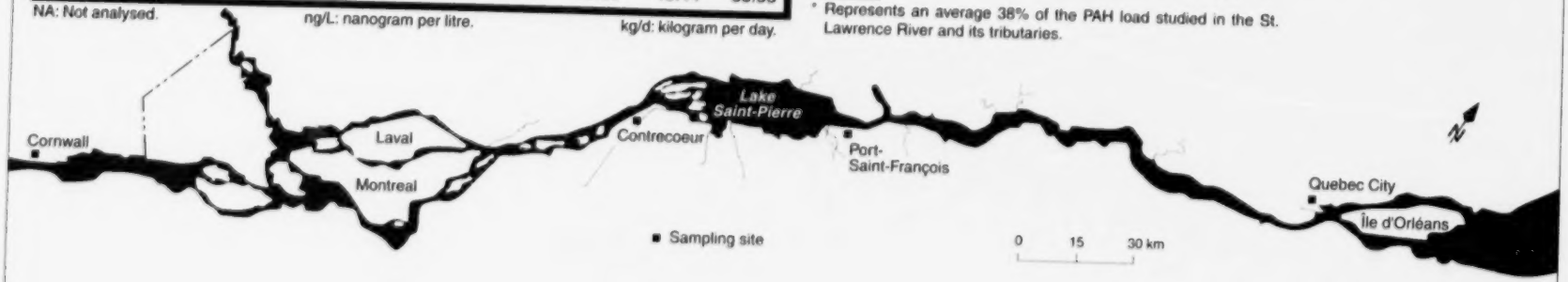
	Cornwall		Contrecoeur		Port-Saint-François		Quebec City	
	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)
Summer 1990	5.61	3.85	9.29	7.44	14.92	11.17	14.51	10.71
Fall 1990	7.15	2.84	14.60	9.07	NA	NA	25.84	34.94
Spring 1991	3.55	1.97	29.68	35.80	25.66	22.25	45.44	58.53

NA: Not analysed. ng/L: nanogram per litre. kg/d: kilogram per day.

PAH COMPOUNDS STUDIED

1) Phenanthrene*
2) Anthracene
3) Fluoranthene
4) Pyrene
5) Benzo(*a*)anthracene
6) Chrysene
7) Benzo(*b*)fluoranthene
8) Benzo(*k*)fluoranthene
9) Benzo(*a*)pyrene
10) Dibenzo(*a,h*)anthracene
11) Benzo(*ghi*)perylene
12) Indeno(1, 2, 3-*cd*)pyrene

* Represents an average 38% of the PAH load studied in the St. Lawrence River and its tributaries.



PAHs (POLYCYCLIC AROMATIC HYDROCARBONS)

Pollution by organic contaminants[1]

Production and use

PAHs are produced by the incomplete combustion of a biomass (e.g. wood) or fossil fuel (e.g. diesel fuel, gasoline, coal). They are generally found in soot, coal tar, distillates and various kinds of oils discharged in industrial effluent. PAHs are also produced naturally by a biomass (micro-organisms, algae) and by geological phenomena (e.g. volcanic eruptions), although at admittedly lower concentrations than those generated by human activities.

Main sources today

It is estimated that approximately 1300 tonnes of PAHs are emitted annually in Quebec (in air, water and solid sources), of which more than 66% comes from aluminum smelters. Other major sources are wood-burning stoves, forest fires, the burning of agricultural refuse, transportation, incineration and industrial processes.

Characteristics and potential effects

PAHs are on the list of priority substances drawn up by Environment Canada and Health Canada. The significance and the nature of the risks posed by these substances have been assessed according to the *Canadian Environmental Protection Act*.

Due to their low solubility, PAHs are closely associated with the inorganic and organic matter in suspended solids and sediment.

Of the dozen PAH compounds studied, numbers 7), 8), 9) and 12) (see upper right-hand corner) are classified as "probably carcinogenic to humans." Moreover, there are increased incidences of liver and other organ tumours in fish living in PAH-contaminated water.

Quality criteria of the Ministère de l'Environnement du Québec (1990):

- Raw water (domestic water intake): 2.8 ng/L
- Aquatic organism contamination: 31.1 ng/L
- Aquatic life (acute toxicity): 300 000 ng/L

1. Refers to Info-Flash fact sheet 51 on types of pollution.

PAHs IN THE ST. LAWRENCE RIVER, BY SOURCE, OCTOBER 1990

(calculated in water and suspended solids)

Source	%
Tributaries (PAHs measured in 10 major tributaries)	17
Great Lakes (PAHs measured at Cornwall)	8
Atmospheric input (estimate)*	52
Other sources (estimate)**	23

* Atmospheric input may be lower in spring and summer.

** Industrial and municipal effluents, oil spills, surface runoff, macrophytes and sediment resuspension.

Note: Percentages were measured in relation to total PAHs measured at Quebec City.

Source:
- Government of Canada. 1994. "Polycyclic Aromatic Hydrocarbons". In *Canadian Environmental Protection Act – Priority Substances List Assessment Report*.
- Ministère de l'Environnement du Québec. 1990. *Critères de qualité de l'eau*.
- NRCC. 1983. *Les hydrocarbures aromatiques polycycliques dans le milieu aquatique : formation, sources, devenir et effets sur le biote aquatique*. National Research Council of Canada, Associate Committee on Scientific Criteria for Environmental Quality. NRCC No. 18982.
- Pham, T.T. 1992. Personal communication. Environment Canada, St. Lawrence Centre, Ecotoxicology and Ecosystems Branch.
- Seuss, M.J. 1976. The environmental load and cycle of polycyclic aromatic hydrocarbons. *Sci. Total Environ.* 6: 239-250.

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March 1997

The St. Lawrence River – Relative Importance of PCBs (1991)

PCB LOADS AND CONCENTRATIONS IN THE RIVER (1991)

	Cornwall		Contrecoeur		Port-Saint-François		Quebec City	
	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	load (kg/d)
Spring 1991	0.357	0.278	0.428	0.546	0.375	0.496	0.632	0.868
Summer 1991	0.114	0.073	0.209	0.158	0.130	0.104	0.141	0.113
Fall 1991	0.043	0.024	0.078	0.058	0.140	0.112	0.271	0.224

ng/L: nanogram per litre. kg/d: kilogram per day.

PCB CONGENERS STUDIED

In all, 13 congeners were analysed: congeners 77, 101, 105, 118, 126, 128, 138, 153, 169, 170, 180, 183 and 194. These represent some 25% of all 209 known congeners.

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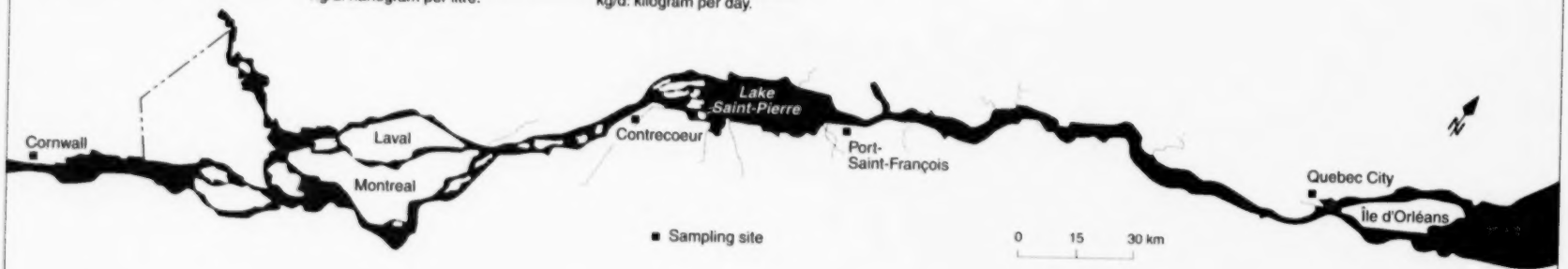

PCBs (POLYCHLORINATED BIPHENYLS)

Pollution by toxic organic contaminants[1]

Production and use

In 1980, Canada banned the manufacture, import and use of PCBs, except in closed electrical equipment like transformers. PCBs were widely used by industry in electrical devices (transformers and capacitors) because of their cooling and insulating properties. They served as components in hydraulic and heat transfer fluids and lubricants, and were employed in the production of rubber, synthetic resins, plastics, paints, textiles and inks. PCBs were also used in insecticides and as dust-suppressing agents on unpaved roads, among other uses. Even though they are rarely used today, PCBs persist throughout the global environment.

Main sources today

The main sources of PCBs in Quebec are industrial wastes, leaching at contaminated sites, and leakage due to faulty transformer seals. Atmospheric inputs of PCBs to the St. Lawrence are far from negligible. The open-air combustion of PCB-containing waste (e.g. municipal incinerators, fires) is only one source among many.

Characteristics and potential effects

PCBs have 209 congeners, very stable compounds which decompose very slowly. They are among the most persistent contaminants in the environment.

In water, they are found mostly on suspended matter and sediments as these are insoluble. PCBs bio-accumulate in the fatty tissues of aquatic organisms (plankton, macro-invertebrates, fish and especially marine mammals). In fact, PCBs are everywhere, even in land mammals (including humans), as well as in Arctic and Antarctic regions. Some PCBs are also thought to have teratogenic and mutagenic properties, and may be carcinogenic.

Quality criteria of the Ministère de l'Environnement du Québec (1990):

- Raw water (domestic water intake) and contamination of aquatic organisms: 0.079 ng/L
- Aquatic life (chronic toxicity): 1 ng/L
- Aquatic life (acute toxicity): 2000 ng/L

1. Refers to Info-Flash fact sheet 51 on types of pollution.

PCBs IN THE ST. LAWRENCE RIVER, BY SOURCE, 1991

(calculated in water and suspended solids)

Source	May	August	Nov.
	%	%	%
Tributaries (PCBs measured in 5 major tributaries)	17	4	6
Great Lakes (PCBs measured at Cornwall)	32	65	11
Industries (effluent from 4 of the 50 Action Plan priority plants)	6	47	24
Other sources (estimate)*	45	-16	59

* Atmospheric deposition, surface runoff, macrophytes and resuspended sediments. A negative result indicates that PCBs settled between Cornwall and Quebec City, probably in macrophytes.

Note: Percentages were calculated in relation to total PCBs measured at Quebec City.

Source:
- CCREM. 1991. *Canadian Water Quality Guidelines.*
- Government of Canada. 1991. *The State of Canada's Environment.*
- Ministère de l'Environnement du Québec. 1990. *Critères de qualité de l'eau.*
- Quémerais, B. 1992. Personal communication. Environment Canada, St. Lawrence Centre, Ecotoxicology and Ecosystems Branch.

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March 1997

The St. Lawrence River – Priority Intervention Zone: Lake Saint-Pierre

A DIVERSIFIED NATURAL ENVIRONMENT

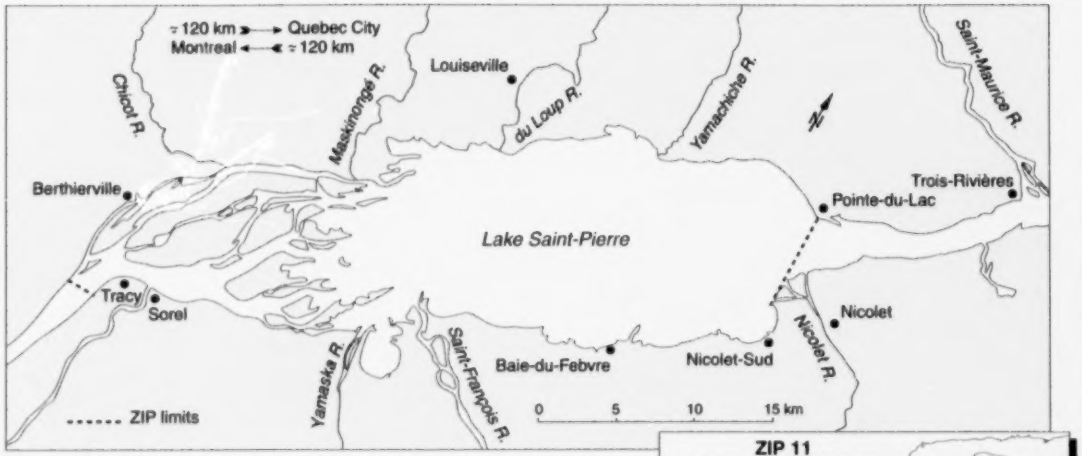
- A fluvial lake with a surface area of 480 km² and an archipelago of some 100 islands.
- Quebec's largest freshwater flood plain (18 000 ha).
- Holds 20% of St. Lawrence wetlands (39 000 ha).
- Home to 79 freshwater fish species, 167 nesting birds and 13 amphibians.
- A major springtime staging area for ducks and geese.
- The largest heronry in North America (over 1300 nests).

HUMAN POPULATION AND ACTIVITIES

- In 1995: 30 municipalities, including 21 riverside municipalities, for a total of 93 000 people.
- Sorel-Tracy: Major industrial centre, 4 Action Plan plants (metallurgy, chemicals).
- Farmlands: 60% of the territory, or 77 630 ha.
- Last bastion of commercial freshwater fishing in Quebec in 1991: 42 permits, 585 tonnes; $1 million in direct economic spinoffs.
- Sport fishing (1986): 24 000 fishers, 304 tonnes; $5 million in direct economic spinoffs.
- Waterfowl hunting: 400 hunters, 55 000 ducks bagged per year, economic spinoffs total $250 000.
- Bird watching (1989): 50 000 visitors, two interpretation centres, 350 000 geese stop over in spring.
- Chalets: 2400 located on islands, shores and at the mouths of tributaries.

MAIN PROBLEMS

- Physical alteration of habitats.
- Conflicting uses:
  - Land: conflict between habitat conservation, farming activities and recreational needs.
  - Species: (e.g. conflict between fishing Yellow perch for commercial ends or for sport).
- Widespread bacterial pollution.
- Toxic substances detected in all compartments of the ecosystem.
- Resource overexploitation (Lake sturgeon).
- Erosion of banks worsened by ship traffic (ship-generated waves), especially on islands.
- Discharges of pollutants from seven SLV 2000 plants along the Saint-François, Richelieu and Yamaska rivers.



Note: Priority Intervention Zones are commonly called by their French acronym, ZIP, for *zones d'intervention prioritaire*.

SOLUTIONS IN ACTION

St. Lawrence Vision 2000 action plan (1993-98)

Protection Component: Seven priority plants subject to the cleanup objectives of SLV 2000.

ZIP Program at the St. Lawrence Centre: Environmental assessment of the ZIP and consultation in partnership with *Stratégies Saint-Laurent* (NGO umbrella group). Preparation of a local ecological rehabilitation action plan (ERAP) for the Lake Saint-Pierre ZIP.

Eastern Habitat Joint Venture (EHJV)

Launched in 1989 for a period of 15 years, the aim of this plan is to protect the wetland areas of Eastern Canada.

Partners in Quebec: Ministère de l'Environnement et de la Faune, Regional Affairs Secretariat, Quebec Wildlife Foundation, Wildlife Habitat Canada, Ducks Unlimited, and Canadian Wildlife Service (Environment Canada). There are a number of projects aimed at protecting 3500 ha of Lake Saint-Pierre wetlands.

Projects at Baie-du-Febvre and Nicolet-Sud

Two projects worth $2.8 million are now being completed thanks to the financial support of EHJV partners. Their aim is to protect and enhance 890 ha of waterfowl staging grounds and fish habitat. These projects are the responsibility of two NGOs (non-governmental organizations): the *Société d'Aménagement Récréatif pour la Conservation de l'Environnement du Lac Saint-Pierre*, and the *Société de Mise en Valeur de la Commune* (SOMICO).

By What Means? Through land purchases, easement agreements and by renting land from more than 40 riverside landowners; creation of interpreted hiking trails, observation towers, and an interpretation centre at Baie-du-Febvre; promotion of harmonized development so as to maintain agricultural activities *and* enhance wildlife habitats.

Source:
- Auclair, M.-J., D. Gingras, J. Harris, and A. Jourdain. 1991. *Synthèse et analyse des connaissances sur les aspects socio-économiques du lac Saint-Pierre : Rapport technique. Zone d'intérêt prioritaire 11.* Environment Canada, St. Lawrence Centre.
- Barabé, A., J.-C. Bourgeois, and R. Trudel. 1995. Dans la vallée du fleuve Saint-Laurent : L'écotourisme au lac Saint-Pierre. *Ecodécision.* Winter 1995.
- Burton, J., 1991. *Le lac Saint-Pierre, Zone d'intérêt prioritaire n° 11, Document d'intégration.* Environment Canada, St. Lawrence Centre.
- Ecological rehabilitation action plan (ERAP) for Lake Saint-Pierre ZIP. Preliminary version. Community Involvement Component of SLV 2000.

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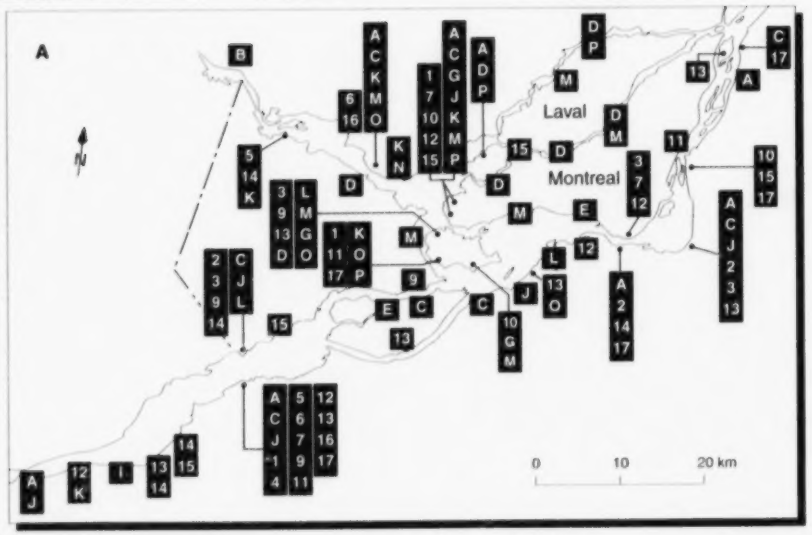
The St. Lawrence River – Amphibians and Reptiles



AMPHIBIAN (from *amphibios*, meaning "capable of living on land or in water"): A vertebrate whose aquatic larvae metamorphose into adults with on-land aptitude. Its skin is not scaly, but contains mucus or venomous glands. Respiratory system is branchial in larvae, pulmonary in adults and cutaneous for both. Amphibians are terrestrial freshwater creatures who cannot tolerate salt water.

1 Mudpuppy (*Necturus maculosus*)*
2 Eastern newt (*Notophtalmus viridescens*)
3 Blue-spotted salamander (*Ambystoma laterale*)
4 Yellow-spotted salamander (*Ambystoma maculatum*)
5 Two-lined salamander (*Eurycea bislineata*)
6 Four-toed salamander (*Hemidactylium scutatum*)
7 Eastern redback salamander (*Plethodon cinereus*)
8 Dusky salamander (*Desmognathus fuscus*)
9 Spring peeper (*Hyla crucifer pseudacris*)
10 Tetraploid gray treefrog (*Hyla versicolor*)
11 Northern chorus frog (*Pseudacris triseriata*)
12 Wood frog (*Rana sylvatica*)
13 Pickerel frog (*Rana pipiens*)
14 Northern leopard frog (*Rana palustris*)
15 Green frog (*Rana clamitans*)
16 Mink frog (*Rana septentrionalis*)
17 Bullfrog (*Rana catesbeiana*)

REPTILE (from *reptilis*, meaning "creeping"): A vertebrate of variable internal temperature, reptiles breathe air from birth. They gave rise to birds and mammals during the evolution of species. Their skin is covered in scales which are capable of ossifying, as they have in the case of the turtle. Most reptiles are sedentary creatures with no social structure. Unlike amphibians, they possess no aquatic larval stage.

A Snapping turtle (*Chelydra serpentina*)*
B Musk turtle (*Sternotherus odoratus*)
C Painted turtle (*Chrysemys picta*)*
D Map turtle (*Graptemys geographica*)*
E Wood turtle (*Clemmys insculpta*)
F Spotted turtle (*Clemmys guttata*)
G Spiny softshell (*Apalona spinifera*)*
H Leatherback turtle (*Dermochelys coriacea*)**
I Blanding's turtle (*Emydoidea blandingi*)
J Common garter snake (*Thamnophis sirtalis*)*
K Northern water snake (*Nerodia sipedon*)
L Redbelly snake (*Storeria occipitomaculata*)
M Brown snake (*Storeria dekayi*)
N Smooth green snake (*Opheodrys vernalis*)
O Ringneck snake (*Diadophis punctatus*)
P Milk snake (*Lampropeltis triangulum*)

* Species sometimes seen only in freshwater zones of the St. Lawrence.
** The Leatherback turtle is the only species to live in a marine environment.

RESOURCE EXPLOITATION

Bullfrogs, Green frogs and Northern leopard frogs are harvested annually for commercial purposes at Lake Saint-Pierre. Some 93 000 were harvested in the early 1980s, 90% of which comprised Northern leopard frogs and 2% Green frogs, with Bullfrogs comprising the remaining 8%. The former two species are captured for laboratories, while Bullfrogs are destined for the dinner table. Of the 18 000 to 23 000 Bullfrogs captured in Quebec, almost 8000 were caught at Lake Saint-Pierre.

SPECIAL STATUS

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has declared the Leatherback turtle endangered, the Spiny softshell threatened and the Spotted turtle vulnerable.

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Source:
- Bider, R., and S. Matte. 1990. *Atlas des amphibiens et des reptiles du Québec, rapport préliminaire*. Société d'Histoire Naturelle de la Vallée du Saint-Laurent and MLCP, Québec.
- Data base of the Centre de données sur le Patrimoine Naturel du Québec (based on data integrated up to November, 1992).
- Langlois, C., L. Lapierre, M. Léveillée, P. Turgeon, and C. Ménard. 1992. *Synthèse des connaissances sur les communautés biologiques du lac Saint-Pierre*. Environment Canada, St. Lawrence Centre.

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March 1997

The St. Lawrence River – Contaminants and Water Quality Criteria (1992)

DEFINITIONS

Criterion

Threshold concentration of a contaminant based on its deleterious effects (toxicity, organolepticity, aesthetics), which, when exceeded, may lead to the total or partial loss of a specific use of the water.

Contaminant

A substance or physical (e.g. heat), chemical (e.g. PCBs) or biological (e.g. fecal coliforms) agent or any combination of one or more of these, liable to somehow alter the quality of the environment.

WATER QUALITY CRITERIA

GOOD WATER QUALITY is essential for the sound health of humans and of biological resources, and for the safe practice of recreational activities.

As such, agencies charged with managing water resources must develop discharge objectives to control the various sources of pollution. Two approaches are generally employed to this end: the technological approach (best available technology), and the environmental approach (establishing environmental discharge objectives based on certain criteria). In Quebec, for example, discharge objectives are generally based on the qualitative and quantitative characteristics of the receiving water, pollution sources and the desired water quality level, according to the potential uses of this environment. Various national and international agencies have defined water quality criteria relative to each of its uses. They include the Canadian Council of Environment Ministers (CCEM), Environment Canada, Health Canada, the Canadian provincial ministers of the environment and health, the International Joint Commission (IJC), the United States Environmental Protection Agency (U.S. EPA), the environmental protection departments of the American states, the World Health Organization (WHO), and the European Economic Community (EEC).

Quality criteria also serve as a reference point to assess the health of the environment, although the "absence of a criterion for a specific parameter does not mean the parameter has no effect or is not dangerous for the given use" (translation).[1] Criteria can be developed for those substances which have none based on studies assessing their toxicity or other harmful effects.

BREAKDOWN OF CONTAMINANTS HAVING WATER QUALITY CRITERIA, BY USE

In Quebec, the MENVIQ has selected the water uses listed in the table below to inventory quality criteria for 355 parameters. These criteria may be descriptive (for the water's aesthetic quality, among other things), related to overall toxicity (targeting the protection of aquatic life, for instance), or numerical (specific to one substance or one use). Numerical criteria reflect "the state of knowledge of the harmful effects of contaminants and are generally expressed in terms of a concentration, which, if exceeded, may lead to the total or partial loss of the use to which it corresponds" (translation).[1]

	WATER USES					
			Aquatic Life		Recreational Activities	
TYPES OF CONTAMINANTS	Raw water intended for domestic consumption	Consumption of aquatic organisms	Acute toxicity	Chronic toxicity	Primary contact	Aesthetic aspects
Inorganic	■	■	■	■	■	■
Organic	■	■	■	■	■	■
Physical	■			■	■	■
Bacterial	■	■			■	
Radioactive	■					
Number of contaminants inventoried	281	87	100	195	30	8

Examples of contaminants

Inorganic: metals (silver, copper, lead, etc.), nitrates, chlorides, cyanides, fluorides, phosphorus, sulphates, etc.

Organic: resin acids, trihalomethanes, benzenes, phenols, PAHs, PCBs, dioxins, oils and greases, pesticides, etc.

Physical: colour, odour, transparency, temperature, turbidity, suspended solids, etc.

Bacterial: fecal coliforms, enterococcus.

Radioactive: caesium, iodes, radium, strontium, tritium.

USES DEFINED

Human Health	
Raw water intended for domestic consumption	Surface waters used for domestic purposes and for drinking, and used by aquatic organisms (as opposed to treated water, which is regulated by a drinking water standard).
Consumption of aquatic organisms	Surface waters for consumption of aquatic organisms and where there are no water intakes.
Aquatic life and related terrestrial wildlife	All types of aquatic life at all stages of development. Toxicity criteria refer to the concentration of a contaminant to which aquatic organisms may be exposed, whether for a short period of time with very little or no mortality (**acute toxicity**), or indefinitely, with no harmful effects (**chronic toxicity**).
Primary contact recreational activities	Recreational activity where the whole body is in regular contact with the water (swimming, sail boarding, water skiing). Some criteria for activities involving secondary contact activities (sailing, canoeing, fishing, etc.) may be included in this category.
Aesthetic aspects, recreational activities	Riverside development (campgrounds, rest areas, parks, etc.).

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Source: 1. Ministère de l'Environnement du Québec. 1990. *Critères de qualité de l'eau*. Service d'évaluation des rejets toxiques and Direction de la qualité des cours d'eau.
2. Guay, I. 1992. *Les critères de qualité de l'eau au Québec : Définitions et application*. Ministère de l'Environnement du Québec, Service d'évaluation des rejets toxiques.

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March 1997

The St. Lawrence River and Biotechnology

	FIELD OF APPLICATION				
Objective	**Improving environmental quality (control at source, cleanup)**			**Monitoring environmental quality**	
Means	**DEVELOPMENT OF LESS-POLLUTING PROCESSES**	**DEVELOPMENT OF METHODS AND TOOLS TO TREAT MUNICIPAL AND INDUSTRIAL EFFLUENTS**	**DEVELOPMENT OF METHODS AND TOOLS TO CLEAN CONTAMINATED SLUDGES AND SOILS (decontamination)**	**DEVELOPMENT OF TOOLS TO MONITOR AND CONTROL DISCHARGES**	**DEVELOPMENT OF TOOLS TO ASSESS THE STATE OF ECOSYSTEMS**
Examples of research completed or in progress	• Biological bleaching of wood pulp using the mushroom *Trametes versicolor*.[1] • Development of a bioherbicide made from microscopic fungi.[1] • Preparation and marketing of a liquid biofertilizer made from algae.[2]	• Study of processes used in the anaerobic digestion of industrial effluent (pulp and paper), using special reactors.[1] • Development or adaptation of tools to control or influence certain procedures: hydrogen probes, genetic probes, bioreactors.[1] • Development of biofilters for the microbiological capture of metals in effluent.[1]	• Research into the degradation of polychlorinated pesticides and PCBs: development and control of bacterial cultures specializing in pollutant biodegradation; study of enzymatic processes to convert these compounds into non-toxic derivatives, which could then be degraded using biological processes.[1] • Development of a solid-phase bioreactor to biologically treat soils and sludges contaminated with toxic substances.[1]	• Development of BOD biosensors to monitor the quality of effluent of petrochemical plants and pulp and paper mills.[1] • Designing piezoelectric crystal immunosensors to detect contaminants in the soil and water.[1] • Development of the PEEP (Potential Ecotoxic Effects Probe), a combination of various bioassays which is currently being used to analyse the effluent discharged by the priority industrial plants (SLC, Ecotoxicology and Environmental Chemistry).	• Development of biotools: micro-bioassays and bioindicators to assess the impact of toxics on the St. Lawrence ecosystem[3]: - MFO-MT bioprobe serves to detect toxic assaults of organic (mixed function oxidases, MFO) and inorganic (metallothionein, MT) origin. - Genotoxicity bioassays to detect toxic assaults against the gene pool. - Use of bioindicators (young Cyprinidae) to assess the bioaccumulation of toxics in the River.

DEFINITION

Biotechnologies

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POTENTIAL ADVANTAGES AND DISADVANTAGES OF BIOTECHNOLOGIES FOR THE ST. LAWRENCE RIVER

"Biotechnologies may constitute a solution to the environmental problems of the St. Lawrence and offset the disadvantages of existing physico-chemical or mechanical cleanup techniques. They may be good bioindicators of the ecosystem, a measuring instrument, cleanup tool, or they may also become a pollution-prevention tool" (translation).[4]

Advantages

- Based in natural processes (enzymatic conversion, fermentation, etc.)
- Consume little energy and treated pollutants are transformed into biomass (biodegradable compounds).
- Less costly than conventional methods because there is no need for expensive industrial infrastructures.
- Faster in certain cases: e.g. accelerate the natural treatment process of wastewater.

Limitations

- Use is currently limited, especially in the case of organic pollution.
- Require more rigourous control (temperature, oxygen, nutrients, etc.) due to the use of living organisms which are very sensitive to ambient conditions.
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THE APPLICATION OF BIOTECHNOLOGY AT ONE PRIORITY PLANT[5]

Shell Canada Products Ltd. of Montreal East has been using an aerobic biodegradation treatment process since 1991 to decontaminate hydrocarbon-contaminated clayey soil. This ongoing project is the result of a collaborative effort between Shell Canada Products Ltd., Groundwater Technology Canada Ltd., the Biotechnology Research Institute (BRI) of the National Research Council of Canada, and the St. Lawrence Centre of Environment Canada. To decontaminate soil, an environment is created to encourage proliferation of naturally-occurring bacteria in the soil—bacteria with the natural hydrocarbon-degrading properties necessary to transform hydrocarbons into biodegradable by-products.

Following treatment trials, this decontamination process was shown to be effective in winter conditions. A biodegradation-monitoring method was also applied. In eight months of treatment, using an aerobic biodegradation process, the hydrocarbon level in the clayey soil dropped from 6670 mg/kg to 794 mg/kg, for a reduction of 88%; the project objective had been to reduce the concentration to below 1000 mg/kg. Roughly 3400 m³ of soil was treated and decontaminated to a level whereby it could be reused as fill material. Treatment costs may vary between $35 and $70 per metric ton, depending on the type of treatment cell used (temporary vs. permanent). Pretreatment costs can vary from $10 to $30 per metric ton.

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The St. Lawrence River – Commercial Marine Fishing Gear

THE MARINE FISHERY, WHICH ACCOUNTED FOR SOME 9056 JOBS IN 1994, functions with the help of a variety of fishing tools and gear. From Cap Tourmente to Blanc-Sablon, and from Bas-Saint-Laurent to the Gaspé, a variety of factors influence the choice of fishing gear, including the species sought and its habitat, and the type of vessel used. The gear itself can be either stationary or mobile.

Stationary gear can either be positioned at one location or employed from a fixed vessel. It includes baited fish hooks (jigs, boulters), traps, groups of stakes (weir) or nets. Shovels and rakes are also considered stationary gear.

Mobile gear, with the exception of the scallop dragger, refers to the nets dragged by one or more boats.

The trawl and gill net are the gear most frequently used aboard vessels of more than ten metric tons (one tonne equals 2.83 m³).

FISHING GEAR	MAIN SPECIES HARVESTED*	LANDINGS IN 1994** (in metric tons)
STATIONARY GEAR		
Crabpots	Snow crab, other crabs	13 739
Traps (1) excluding Snow crab	Cod, lobster	3 261
Weir (2)	Capelin, herring, shad, eel	460
Gill nets (3)	Mackerel, smelt, salmon, halibut, cod, herring, turbot	8 374
Boulters	Halibut, cod	451
Rakes, shovels, hakes	Clams, oysters	519
Trap	Cod	833
Jig	Cod, mackerel, squid	2 590
MOBILE GEAR		
Shrimp trawl	Shrimp	10 382
Bottom trawl (4)	Halibut, cod, plaice, redfish, shrimp	2 350
Pelagic stern trawl	Herring, mackerel, redfish, haddock, capelin	2 367
Scallop dragger	Scallops	2 590
Seine	Cod, hake, plaice	1 166
TOTAL		49 082

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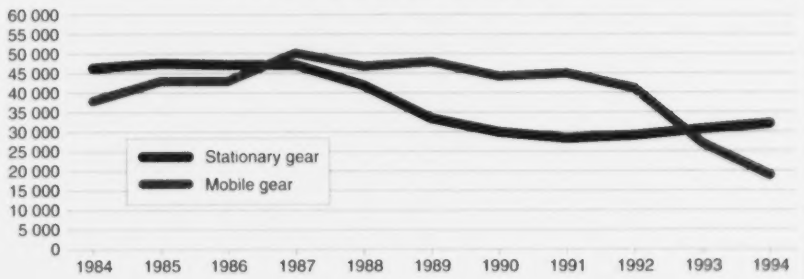
VOLUME OF LANDINGS (IN METRIC TONS) USING STATIONARY AND MOBILE GEAR FROM 1984 TO 1994



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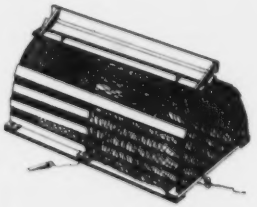

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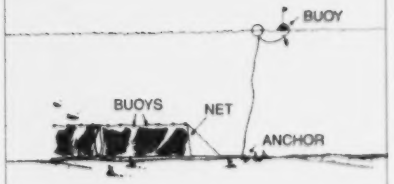

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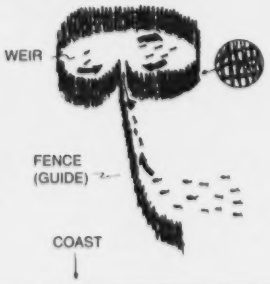

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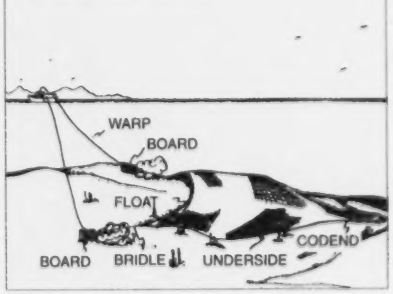

Source:
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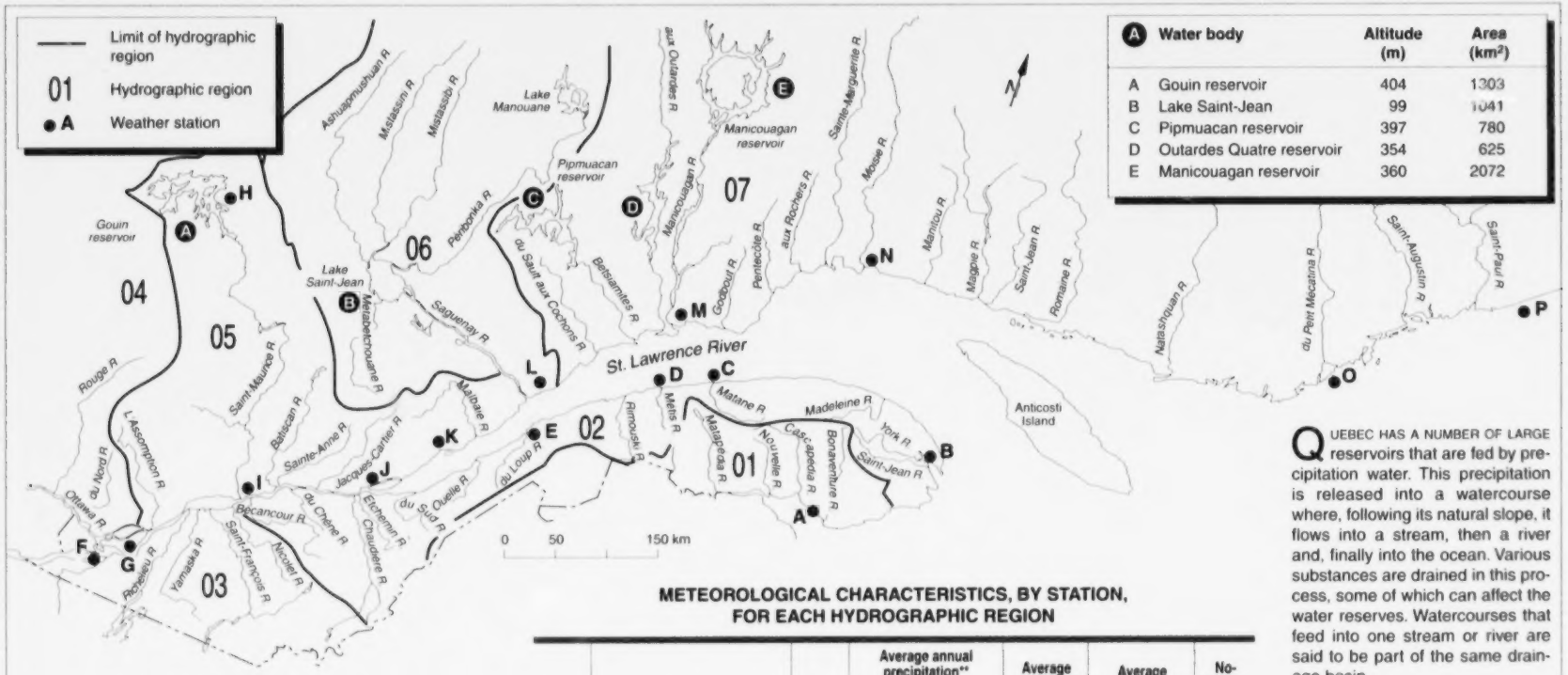
The St. Lawrence River – Drainage Basin Hydrology



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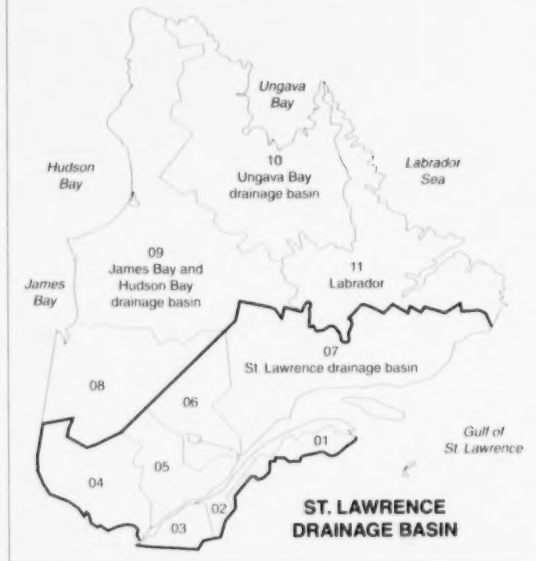

ST. LAWRENCE DRAINAGE BASIN

METEOROLOGICAL CHARACTERISTICS, BY STATION, FOR EACH HYDROGRAPHIC REGION

Region	Station*	Altitude (m)	Average annual precipitation** (1951-1980) Snow (cm)	Total (cm)	Average number of days of precipitation	Average temperature (°C) January	July	No-freeze period (d)
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	C Matane	30	242	102.1	163	-8.7	21.8	177
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The St. Lawrence River – Commercial Marine Fishing Gear

THE MARINE FISHERY, WHICH ACCOUNTED FOR SOME 9056 JOBS IN 1994, functions with the help of a variety of fishing tools and gear. From Cap Tourmente to Blanc-Sablon, and from Bas-Saint-Laurent to the Gaspé, a variety of factors influence the choice of fishing gear, including the species sought and its habitat, and the type of vessel used. The gear itself can be either stationary or mobile.

Stationary gear can either be positioned at one location or employed from a fixed vessel. It includes baited fish hooks (jigs, boulters), traps, groups of stakes (weir) or nets. Shovels and rakes are also considered stationary gear.

Mobile gear, with the exception of the scallop dragger, refers to the nets dragged by one or more boats.

The trawl and gill net are the gear most frequently used aboard vessels of more than ten metric tons (one tonne equals 2.83 m³).

FISHING GEAR	MAIN SPECIES HARVESTED*	LANDINGS IN 1994** (in metric tons)
STATIONARY GEAR		
Crabpots	Snow crab, other crabs	13 739
Traps (1) excluding Snow crab	Cod, lobster	3 261
Weir (2)	Capelin, herring, shad, eel	460
Gill nets (3)	Mackerel, smelt, salmon, halibut, cod, herring, turbot	8 374
Boulters	Halibut, cod	451
Rakes, shovels, hakes	Clams, oysters	519
Trap	Cod	833
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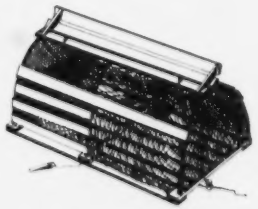

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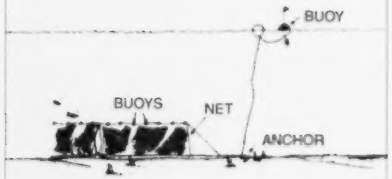

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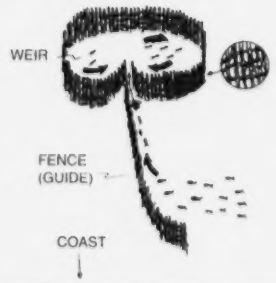

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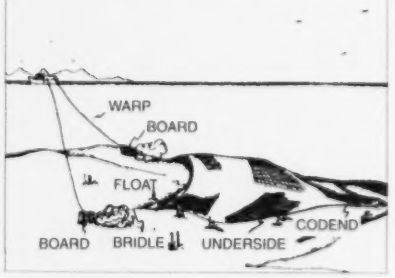

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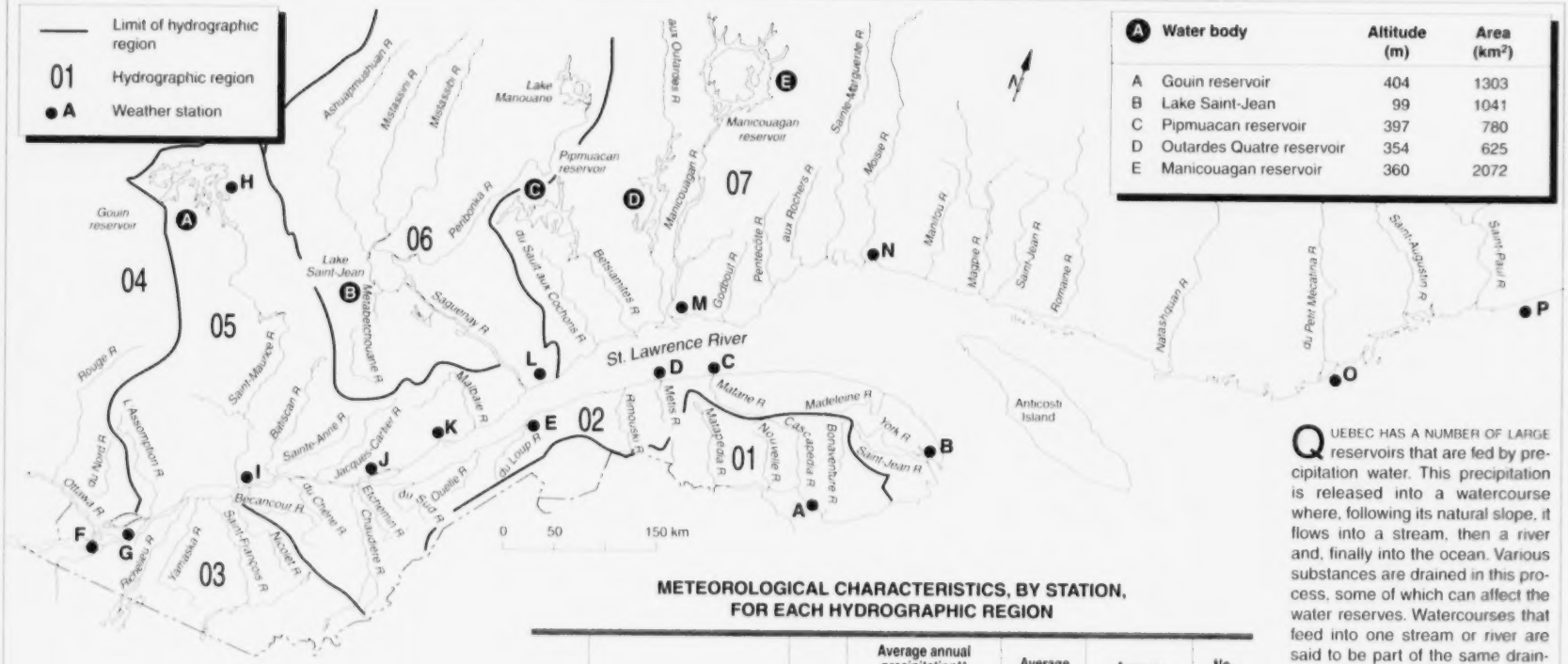
The St. Lawrence River – Drainage Basin Hydrology



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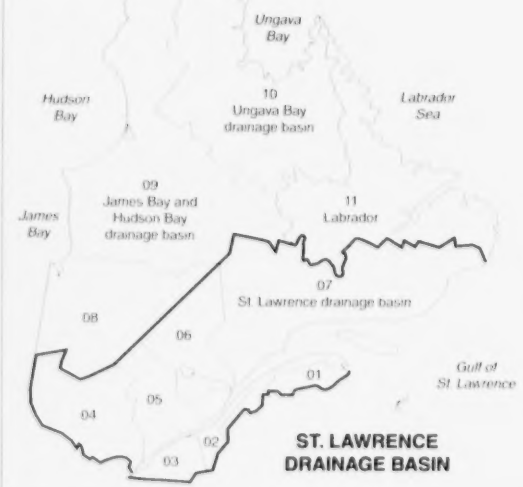

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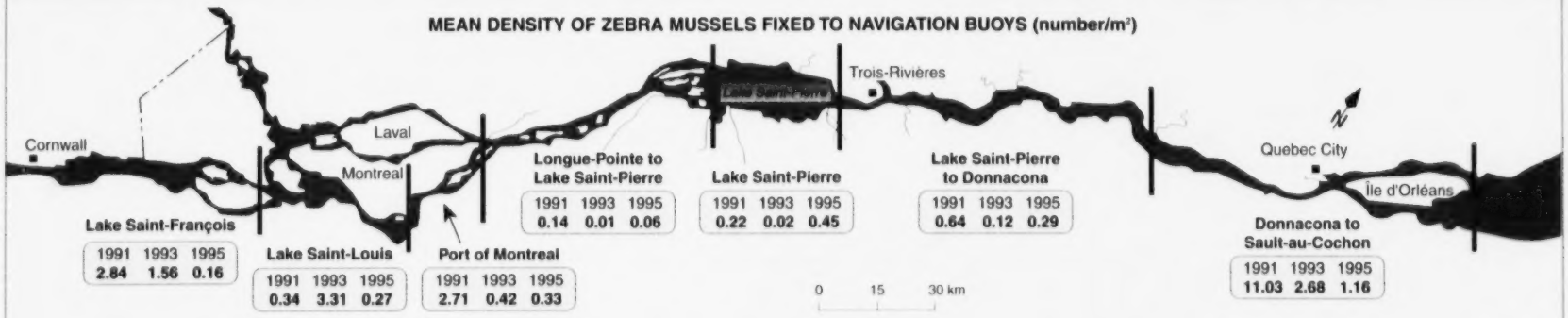
March 1997

The St. Lawrence River and the Invasion of the Zebra Mussel

INFORMATION ON ANNUAL RECRUITMENT RATES (NEW MUSSELS) OF ZEBRA MUSSELS AND QUAGGA MUSSELS can be obtained by monitoring the populations found on navigation buoys. Colonization rates were particularly high in 1991, with the highest concentrations of mussels found immediately downstream of Montreal and in the Quebec City area. Mussel density in the St. Lawrence River may be especially high in areas where the substrate is suitable to colonization. For instance, 9989 mussels/m² were observed at the wharf of Bécancour (artificial substrate) in 1996, whereas barely 18/m² were reported at this same spot only five years earlier. And at Beauharnois, on a natural substrate, there were some 1132/m² mussels in 1996 compared to only 5/m² in 1991.

MEAN DENSITY OF ZEBRA MUSSELS FIXED TO NAVIGATION BUOYS (number/m²)



ORIGINS AND INTRODUCTION

The Zebra mussel *Dreissena polymorpha* is a freshwater bivalve mollusc with roots in the Caspian Sea. It was seen for the first time in North America in 1988 in Lake St. Clair, Ontario, where it is believed to have been introduced in 1986 in the ballast water of a European ship. Zebra mussels were first spotted in the St. Lawrence River in 1989

BIOLOGY AND ECOLOGY

The Zebra mussel can reach 4 cm in length and live for between three to five years. It is a sedentary, filtering organism that consumes bacteria, plankton and organic waste particles. A single female can produce up to 40 000 eggs per year.

Zebra mussels can colonize several different types of habitats. Species dispersal is promoted by strong currents, which carry away larvae. Because adults live affixed to a hard substrate, they are often found on piers, boat hulls, buoys, pipes, fishing nets, rocks and even on other organisms such as molluscs or crayfish. They live in colonies, sometimes at very high densities (300 000/m² in Lake Erie). They have few natural predators except for a few diving ducks and mollusc-eating fish.

The calcium content of the water, its pH level, depth, current, temperature and the type of substrate in some areas of the St. Lawrence promote proliferation of the Zebra mussel. However, the absence of hard natural substrates and the increasing salinity of the water downstream of Île d'Orléans limit the mussel's dispersal and multiplication.

Inedible, Zebra mussels are too small, give off an unpleasant odour when cooked, and have a foul taste.

ECOLOGICAL AND ECONOMIC IMPACTS

Problems have followed the arrival of the Zebra mussel in the Great Lakes and the St. Lawrence River.

Disruption of the food chain: Zebra mussels consume enormous quantities of phytoplankton, thereby disrupting the food networks of many species and, in turn, hindering commercial and sport fishing. They have a direct impact on other freshwater mussels with which they compete, leading to mortality and decreased abundance.

Toxic transmission: Mussels rapidly accumulate pollutants in their tissue, and at concentrations as much as 10 000 times higher than in the environment. They are thus good bioindicators of the quality of the aquatic environment. These toxics travel up the food chain, and may eventually make their way to humans who dine on fish or duck.

Obstruction of municipal and industrial water intakes/outlets: This problem can severely reduce the flow rate of water and foul pumping and filtration systems.

Hindrance of various recreational activities: Zebra mussels can clog cooling water intakes on motor boats, causing engines to overheat. The sharp-edged shells that accumulate on the beach can injure swimmers.

Between 1989 and 1995, the presence of Zebra mussels in the Great Lakes cost both Canada and the U.S. an estimated $100 million in monitoring and control costs. All of the chemical methods that may be effective in controlling the proliferation of Zebra mussels have some impact on the environment. Chlorination is the sole method permitted in Canada at this time. Biological control methods are still being developed.

THE QUAGGA MUSSEL

Two species of exotic mussel have made their home in the St. Lawrence River since 1992. The Quagga mussel *Dreissena bugensis* belongs to the same family as the Zebra mussel and was first observed in North America in Lake Ontario in 1991. Very little is known about its needs, and thus far, it is much fewer in number than its striped cousin. However, the proportion of Quagga mussels attached to navigation buoys grew from 0% in 1991 to 3.9% in 1993 and then to 6.4% in 1995.

Source:
- Doyon, N., B. Cusson, J. Fontaine, C. Ménard, and L. Lapierre. 1992. *Revue documentaire sur la biologie et l'écologie de la Moule zébrée* Dreissena polymorpha. Environment Canada, St. Lawrence Centre.
- Lapierre, L. and Y. de Lafontaine. 1996. *Colonisation de l'épave du* Lady Sherbrooke *par les Moules zébrées.* Environment Canada, St. Lawrence Centre. Scientific and Technical Report ST-48.
- Lapierre, L., J. Fontaine, B. Cusson, and C. Ménard. 1994. *Distribution spatiale des larves et stades fixés de la Moule zébrée,* Dreissena polymorpha, *dans le Saint-Laurent au cours de 1991.* Environment Canada, St. Lawrence Centre.

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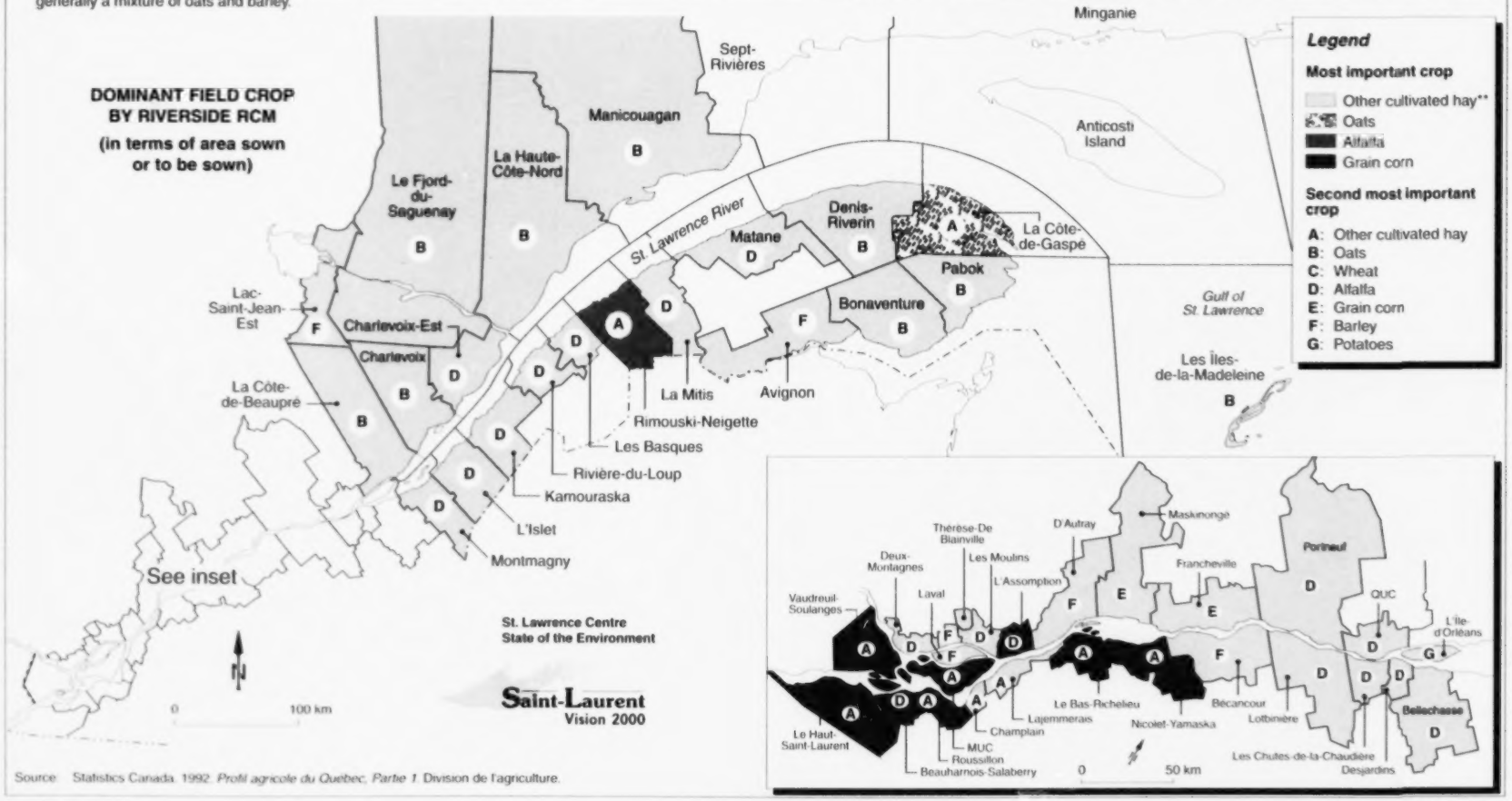
The St. Lawrence River – Main Field Crops (1991)

SURFACE AREA (ha)* OF MAIN FIELD CROPS SOWN OR TO BE SOWN IN 46 RIVERSIDE REGIONAL COUNTY MUNICIPALITIES (RCMs)**

	Other cultivated hay**	Alfalfa	Grain corn	Barley	Oats	Wheat	Mixed grain**	Silage corn	Potatoes	Soya
Riverside RCMs	246 417	115 657	115 401	86 169	47 809	17 644	11 463	11 343	11 319	9 928
Quebec	644 106	217 548	293 758	157 387	96 348	37 461	25 668	31 756	17 515	25 271
RCM/Quebec (%)	38	53	39	55	50	47	45	36	64	39
Main productive RCMs	1. Lotbinière 2. Bellechasse 3. Kamouraska	1. Kamouraska 2. Nicolet-Yamaska 3. Rimouski-Neigette	1. Vaudreuil-Soulanges 2. Nicolet-Yamaska 3. Le Haut-Saint-Laurent	1. D'Autray 2. Bellechasse 3. Nicolet-Yamaska	1. Lac-Saint-Jean-Est 2. Le Fjord-du-Saguenay 3. Rivière-du-Loup	1. Lajemmerais 2. D'Autray 3. Le Bas-Richelieu	1. Kamouraska 2. Nicolet-Yamaska 3. Le Haut-Saint-Laurent	1. Le Haut-Saint-Laurent 2. Beauharnois-Salaberry 3. Nicolet-Yamaska	1. D'Autray 2. L'Île-d'Orléans 3. Le Fjord-du-Saguenay	1. Vaudreuil-Soulanges 2. Roussillon 3. Le Bas-Richelieu

* These areas were determined by combining data on the 46 riverside RCMs. Data was estimated in cases where this information is confidential. The Manicouagan and Minganie RCMs are part of a much larger territory that includes all of northern Quebec, which is why they are not considered here. Farming is a marginal activity in the northern territory.

** "Field crops" are crops farmed on a large scale. The main fodder crop (or hay) is alfalfa. The "other cultivated hay" category includes all other types of annual fodder crop such as clover. The "mixed grain" category is generally a mixture of oats and barley.



Source: Statistics Canada. 1992. *Profil agricole du Québec, Partie 1*. Division de l'agriculture.

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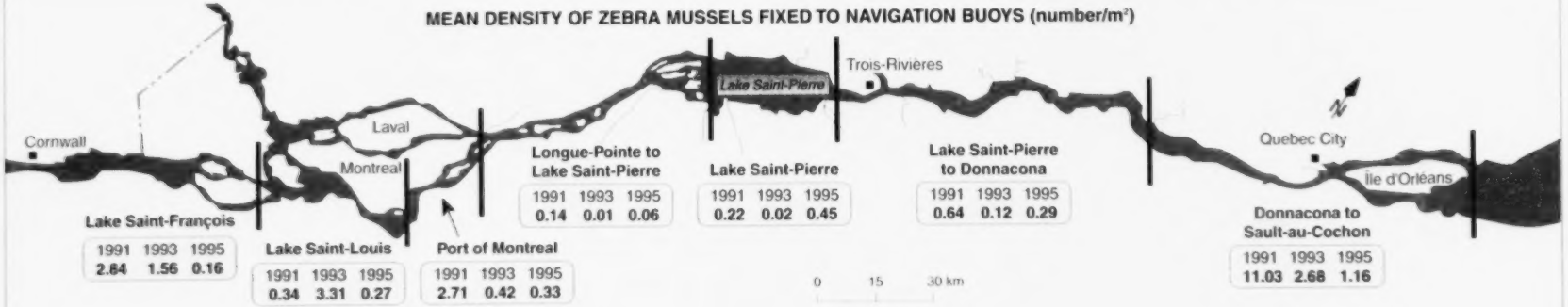

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Toxic transmission: Mussels rapidly accumulate pollutants in their tissue, and at concentrations as much as 10 000 times higher than in the environment. They are thus good bioindicators of the quality of the aquatic environment. These toxics travel up the food chain, and may eventually make their way to humans who dine on fish or duck.

Obstruction of municipal and industrial water intakes/outlets: This problem can severely reduce the flow rate of water and foul pumping and filtration systems.

Hindrance of various recreational activities: Zebra mussels can clog cooling water intakes on motor boats, causing engines to overheat. The sharp-edged shells that accumulate on the beach can injure swimmers.

Between 1989 and 1995, the presence of Zebra mussels in the Great Lakes cost both Canada and the U.S. an estimated $100 million in monitoring and control costs. All of the chemical methods that may be effective in controlling the proliferation of Zebra mussels have some impact on the environment. Chlorination is the sole method permitted in Canada at this time. Biological control methods are still being developed.

THE QUAGGA MUSSEL

Two species of exotic mussel have made their home in the St. Lawrence River since 1992. The Quagga mussel *Dreissena bugensis* belongs to the same family as the Zebra mussel and was first observed in North America in Lake Ontario in 1991. Very little is known about its needs, and thus far, it is much fewer in number than its striped cousin. However, the proportion of Quagga mussels attached to navigation buoys grew from 0% in 1991 to 3.9% in 1993 and then to 6.4% in 1995.

Source:
- Doyon, N., B. Cusson, J. Fontaine, C. Ménard, and L. Lapierre. 1992. *Revue documentaire sur la biologie et l'écologie de la Moule zebrée* Dreissena polymorpha. Environment Canada, St. Lawrence Centre.
- Lapierre, L. and Y. de Lafontaine. 1996. *Colonisation de l'épave du* Lady Sherbrooke *par les Moules zébrées*. Environment Canada, St. Lawrence Centre. Scientific and Technical Report ST-48.
- Lapierre, L., J. Fontaine, B. Cusson, and C. Ménard. 1994. *Distribution spatiale des larves et stades fixés de la Moule zébrée*, Dreissena polymorpha, *dans le Saint-Laurent au cours de 1991*. Environment Canada, St. Lawrence Centre.

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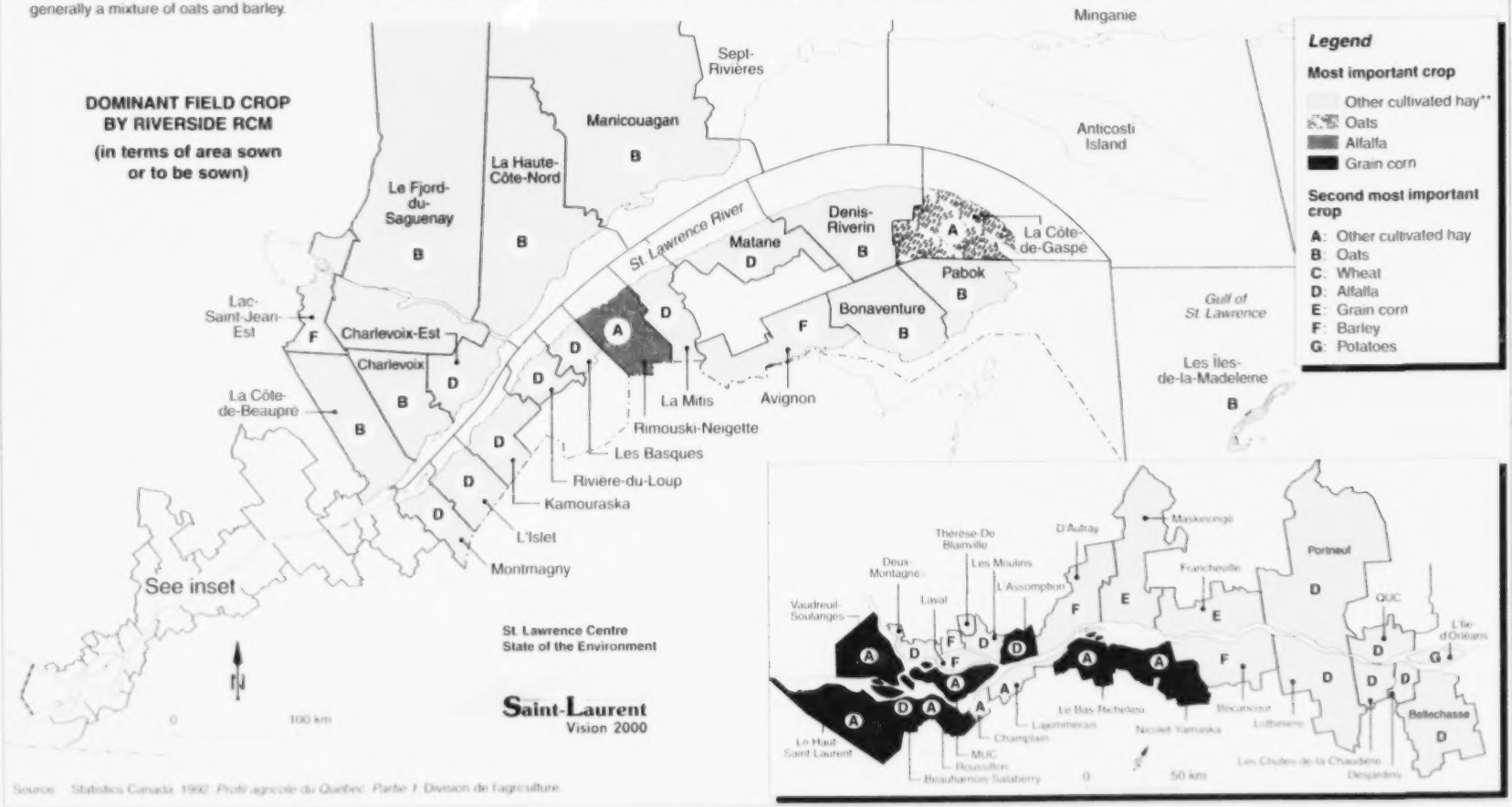
The St. Lawrence River – Main Field Crops (1991)

SURFACE AREA (ha)* OF MAIN FIELD CROPS SOWN OR TO BE SOWN IN 46 RIVERSIDE REGIONAL COUNTY MUNICIPALITIES (RCMs)**

	Other cultivated hay**	Alfalfa	Grain corn	Barley	Oats	Wheat	Mixed grain**	Silage corn	Potatoes	Soya
Riverside RCMs	246 417	115 657	115 401	86 169	47 809	17 644	11 463	11 343	11 319	9 928
Quebec	644 106	217 548	293 758	157 387	96 348	37 461	25 668	31 756	17 515	25 271
RCM/Quebec (%)	38	53	39	55	50	47	45	36	64	39
Main productive RCMs	1. Lotbinière 2. Bellechasse 3. Kamouraska	1. Kamouraska 2. Nicolet-Yamaska 3. Rimouski-Neigette	1. Vaudreuil-Soulanges 2. Nicolet-Yamaska 3. Le Haut-Saint-Laurent	1. D'Autray 2. Bellechasse 3. Nicolet-Yamaska	1. Lac-Saint-Jean-Est 2. Le Fjord-du-Saguenay 3. Rivière-du-Loup	1. Lajemmerais 2. D'Autray 3. Le Bas-Richelieu	1. Kamouraska 2. Nicolet-Yamaska 3. Le Haut-Saint-Laurent	1. Le Haut-Saint-Laurent 2. Beauharnois-Salaberry 3. Nicolet-Yamaska	1. D'Autray 2. L'Île-d'Orléans 3. Le Fjord-du-Saguenay	1. Vaudreuil-Soulanges 2. Roussillon 3. Le Bas-Richelieu

* These areas were determined by combining data on the 46 riverside RCMs. Data was estimated in cases where this information is confidential. The Manicouagan and Minganie RCMs are part of a much larger territory that includes all of northern Quebec, which is why they are not considered here. Farming is a marginal activity in the northern territory.

** "Field crops" are crops farmed on a large scale. The main fodder crop (or hay) is alfalfa. The "other cultivated hay" category includes all other types of annual fodder crop such as clover. The "mixed grain" category is generally a mixture of oats and barley.



Source: Statistics Canada, 1992. *Profil agricole du Québec. Partie 1*. Division de l'agriculture.

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The St. Lawrence River – Livestock Production (1991)

OVERVIEW OF MAIN TYPES OF ANIMAL FARMING IN 46 RIVERSIDE REGIONAL COUNTY MUNICIPALITIES (RCMs)

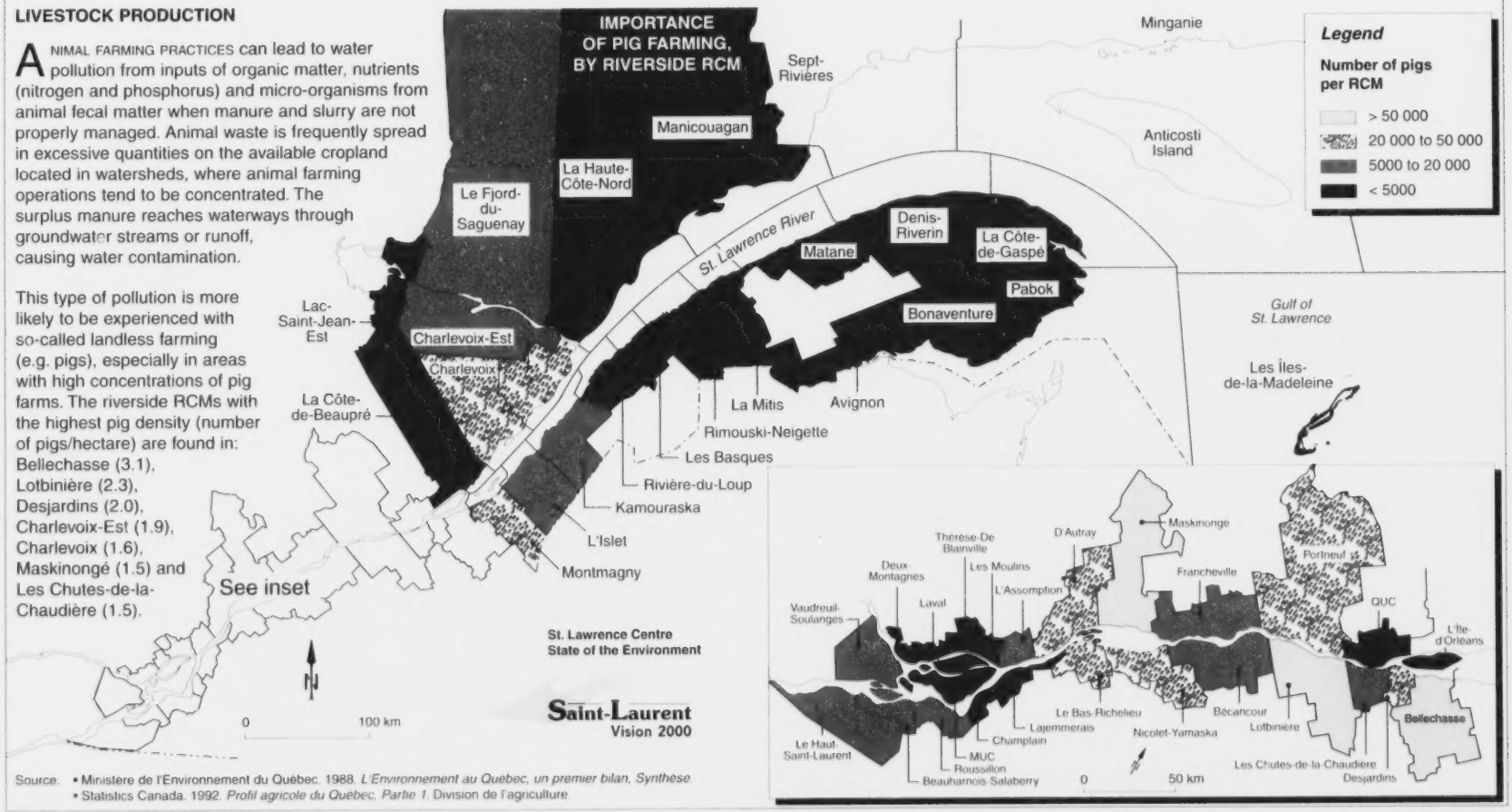
	Chickens		Pigs		Cattle		Sheep	
	Number of reporting farms	Number of animals	Number of reporting farms	Number of animals	Number of reporting farms	Number of animals	Number of reporting farms	Number of animals
Riverside RCMs	1 375	8 149 421	1 246	846 273	9 229	575 585	403	55 524
Quebec	3 611	23 035 296	3 614	2 909 251	22 388	1 445 906	1 117	121 253
RCM/Quebec (%)	38	35	34	29	41	40	36	46
Relative importance (%):	1. D'Autray	19	1. Bellechasse	27	1. Lotbinière	8	1. La Mitis	13
Number of animals raised per RCM	2. Bellechasse	14	2. Lotbinière	20	2. Bellechasse	8	2. Kamouraska	11
X 100	3. Maskinongé	8	3. Maskinongé	8	3. Nicolet-Yamaska	6	3. Rimouski-Neigette	9
Number of animals raised in riverside RCMs	4. Nicolet-Yamaska	7	4. Nicolet-Yamaska	6	4. Le Haut-Saint-Laurent	6	4. L'Islet	7
	5. L'Islet	6	5. D'Autray	4	5. Kamouraska	5	5. Lac-Saint-Jean-Est	6
	Total	**54**	**Total**	**65**	**Total**	**33**	**Total**	**46**

Note: The Sept-Rivières and Minganie RCMs are part of a much larger territory that includes all of northern Quebec, which is why they are not considered here. Animal farming is a marginal activity in this northern territory.

LIVESTOCK PRODUCTION

ANIMAL FARMING PRACTICES can lead to water pollution from inputs of organic matter, nutrients (nitrogen and phosphorus) and micro-organisms from animal fecal matter when manure and slurry are not properly managed. Animal waste is frequently spread in excessive quantities on the available cropland located in watersheds, where animal farming operations tend to be concentrated. The surplus manure reaches waterways through groundwater streams or runoff, causing water contamination.

This type of pollution is more likely to be experienced with so-called landless farming (e.g. pigs), especially in areas with high concentrations of pig farms. The riverside RCMs with the highest pig density (number of pigs/hectare) are found in: Bellechasse (3.1), Lotbinière (2.3), Desjardins (2.0), Charlevoix-Est (1.9), Charlevoix (1.6), Maskinongé (1.5) and Les Chutes-de-la-Chaudière (1.5).



Source: • Ministère de l'Environnement du Québec. 1988. *L'Environnement au Québec, un premier bilan, Synthèse.*
• Statistics Canada. 1992. *Profil agricole du Québec, Partie 1.* Division de l'agriculture.

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The St. Lawrence River – Farmlands and Pesticide Application (1991)

AREA OF FARMLAND SPRAYED WITH PESTICIDES IN 46 RIVERSIDE REGIONAL COUNTY MUNICIPALITIES (RCMs)

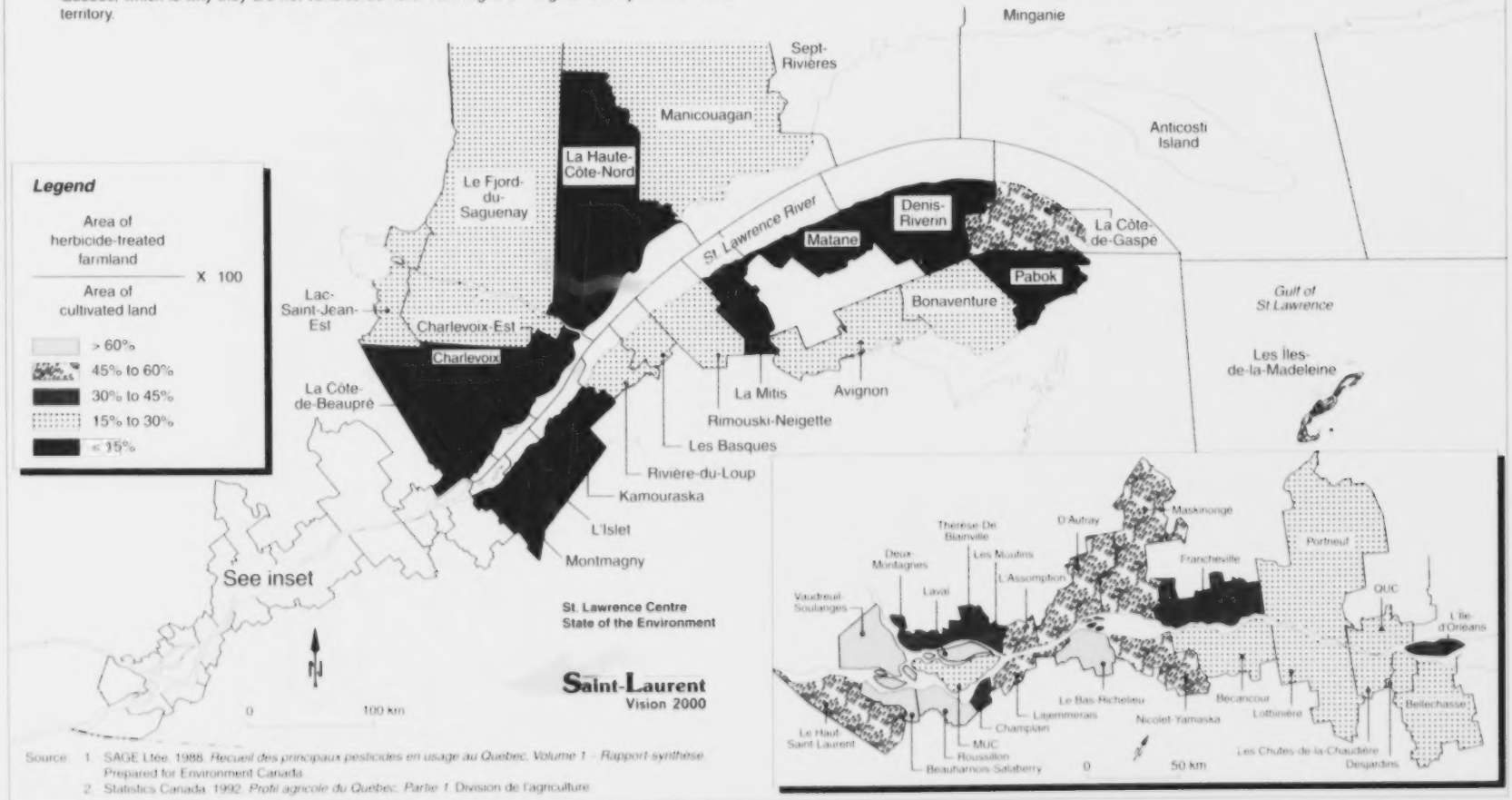
	Herbicides (ha)	Insecticides or fungicides (ha)	Herbicides/ Cultivated land (%)	Insecticides or fungicides/ Cultivated land (%)
Riverside RCMs	250 499	43 221	35	6
Quebec	564 330	96 285	34	6
RCM/Quebec (%)	44	45	–	–

Note: Cultivated lands cover a surface area of 712 216 hectares in the 46 riverside RCMs and 1 638 453 ha in all of Quebec. These areas include land for field crops, fruit, vegetables, sod and nursery stock. The Sept-Rivières and Minganie RCMs are part of a much larger territory that includes all of northern Quebec, which is why they are not considered here. Farming is a marginal activity in this northern territory.

PESTICIDES

"Pesticides are chemical or biological substances that are used to destroy or control those organisms generally termed *pests*, whose activities run counter to what humans consider their best interests" (translation).[1] Pesticides include herbicides (which are used to destroy undesirable plants), insecticides (used to kill certain insects), and fungicides (used to prevent and check illness caused by parasitic fungi). Pesticides employed in farming serve principally to treat cultivated land.

PROPORTION OF CULTIVATED LAND TREATED WITH HERBICIDES, BY RIVERSIDE RCM



Source: 1. SAGE Ltee. 1988. *Recueil des principaux pesticides en usage au Québec. Volume 1 – Rapport synthèse.* Prepared for Environment Canada.
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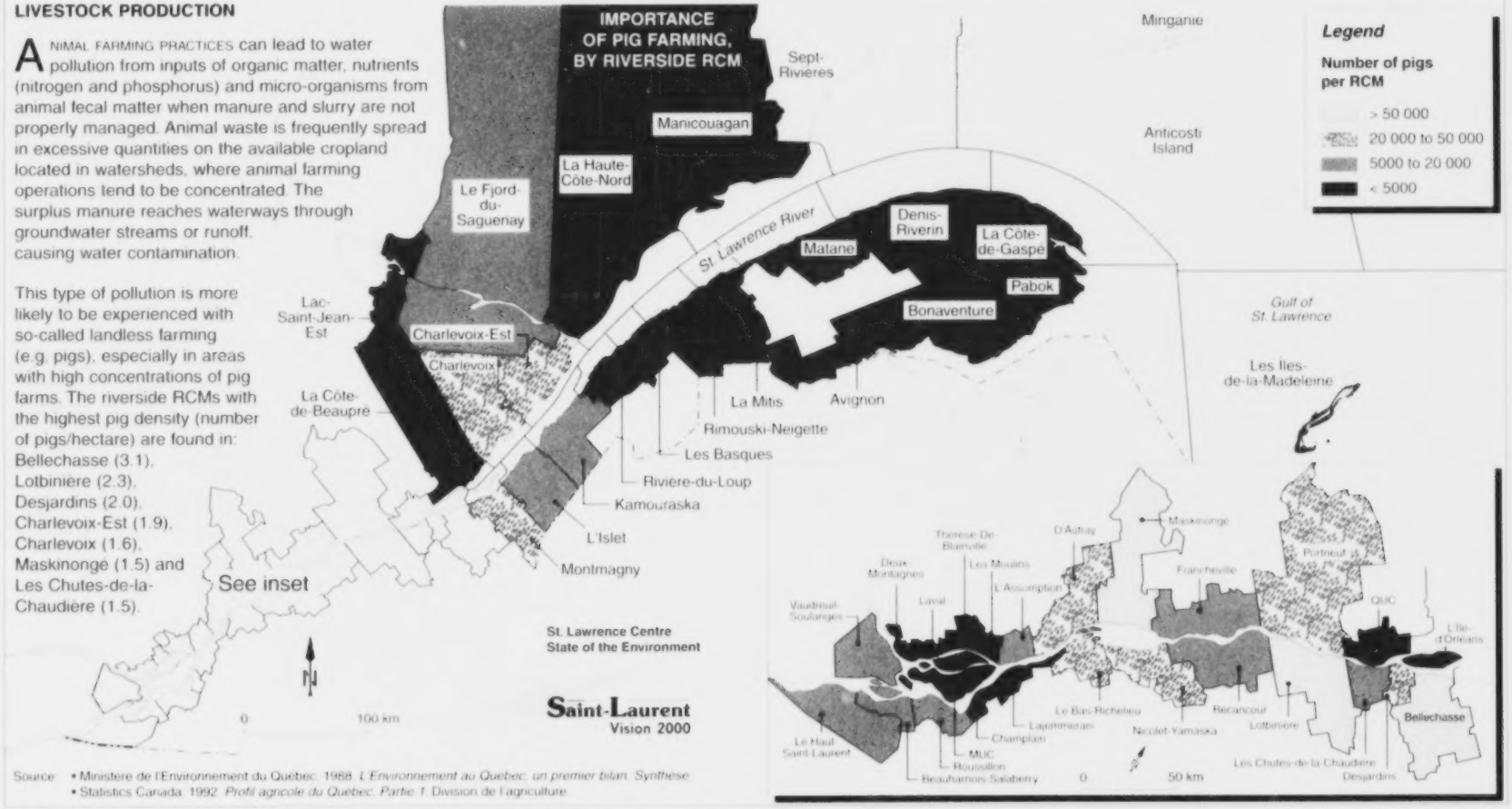

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Source: • Ministère de l'Environnement du Québec. 1988. *L'Environnement au Québec, un premier bilan. Synthèse.*
• Statistics Canada. 1992. *Profil agricole du Québec. Partie 1.* Division de l'agriculture.

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The St. Lawrence River – Relative Importance of Diazinon (1991)

DIAZINON LOADS AND CONCENTRATIONS IN THE ST. LAWRENCE (1991)[1]

	Cornwall		Contrecoeur		Port-Saint-François		Quebec City	
	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)
Spring	0.044	0.034	3.955	5.051	3.870	4.918	7.584	10.419
Summer	2.065	1.312	0.272	0.205	0.742	0.593	5.487	4.390
Fall	6.107	3.451	3.218	2.410	2.854	2.288	7.922	6.550

ng/L: nanogram per litre. kg/d: kilogram per day.

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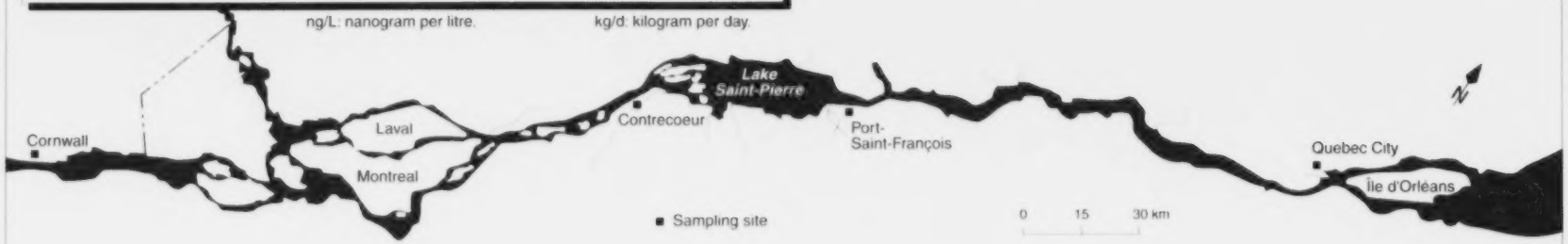


DIAZINON

Pollution by organic contaminants*

Production and use

"Diazinon is a broad-spectrum contact insecticide and acaricide [controls acarids like spiders, mites and ticks that damage crops and related products] used primarily for crop protection, especially fruit trees, corn, tobacco and potatoes. Small amounts are used for the treatment of ornamental plants, domestic animals, lawns and gardens, and it is also used in households, food processing plants and warehouses."[2] Diazinon is reapplied a few times throughout the growing season, from the end of May to mid-June, then again in mid-July and throughout the month of August.

Main sources today

"Although no specific information exists, the predominant route of entry of diazinon into the aquatic environment is believed to be runoff from agricultural lands. Barring accidental spillage and drift spray, agricultural runoff should account for most occurrences of diazinon in aquatic systems."[2] According to the study conducted by Lemieux et al.[1] in 1991, diazinon loads generally increase from Cornwall to Quebec City, especially in spring-time, and would seem to indicate that there are significant sources of diazinon in Quebec City.

The load more than doubles between Port-Saint-François and Quebec City. Losses occur between Cornwall and Contrecoeur in spring and fall, despite an increase in the suspended solids with which diazinon is most often associated.

Characteristics and potential effects

According to Environment Canada (1988), diazinon is considered moderately toxic for mammals, fish and aquatic invertebrates, and highly toxic for birds. Its persistence is average in water (six months to one year), in soil (seven to 18 months), and also in aquatic organisms.

Quality criteria of the Ministère de l'Environnement du Québec (1990):

- Raw water (domestic water intake): 20 000 ng/L
- Aquatic life (chronic toxicity): 3 ng/L.

* Refers to Info-Flash fact sheet 51 on types of pollution.

DIAZINON IN THE ST. LAWRENCE RIVER, BY SOURCE, 1991
(calculated in water and suspended solids)

	May	*August*	*Nov.*
Source	%	%	%
Lake Saint-Pierre tributaries (diazinon measured in 4 tributaries)**	4	4	2
Ottawa River	16	11	11
Great Lakes (diazinon measured at Cornwall	< 1	30	53
Other sources (estimate)***	80	55	34

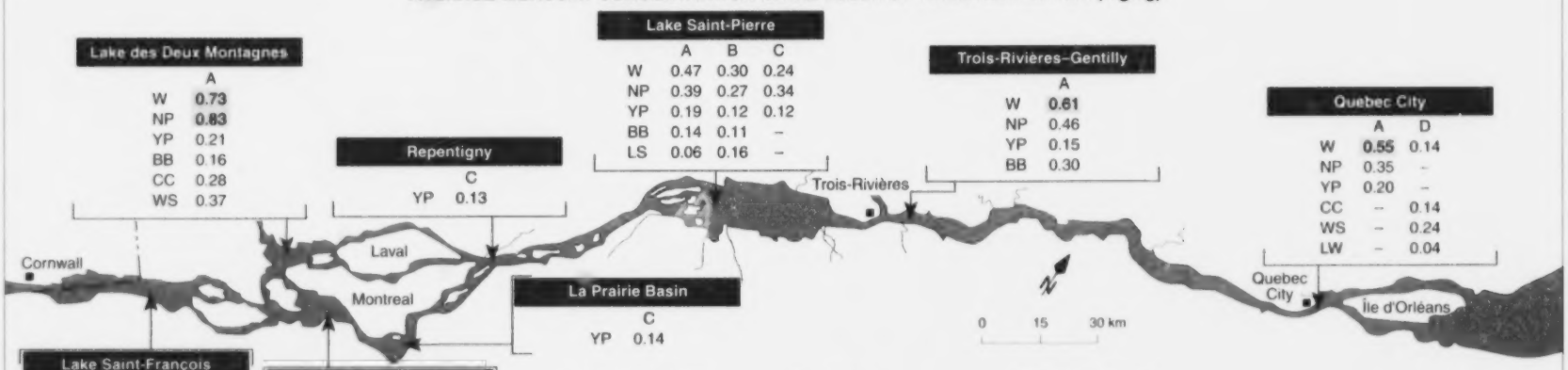
** Tributaries studied: Richelieu, Yamaska, Saint-François, Nicolet rivers.
*** Tributaries not studied, atmospheric deposition, surface runoff, sediment resuspension.

Note: Percentages were calculated in relation to the total diazinon measured at Quebec City.

Source:
1. Lemieux, C., B. Quémerais, and K.R. Lum. 1992. *Tendances temporelles de l'atrazine et du diazinon dans le fleuve Saint-Laurent et certains de ses tributaires.* Environment Canada, St. Lawrence Centre. Presented at the Canadian Association on Water Pollution Research and Control, 8th Eastern Region Conference.
2. Canadian Council of Resource and Environment Ministers. 1991. *Canadian Water Quality Guidelines.* Chapter 6.
3. SAGE Ltee. 1988. *Recueil des principaux pesticides en usage au Québec. Vol. 1 – Rapport-synthèse.* Prepared for Environment Canada.
4. Ministère de l'Environnement du Québec. 1990. *Critères de la qualité de l'eau.*

The St. Lawrence River – Mercury Contamination of Adult Fish

AVERAGE MERCURY CONCENTRATION IN THE FLESH OF FRESHWATER FISH (mg/kg)



A Data from 1985[1].
B Data from 1989[2].
C Data from 1991, 1992 or 1993[2,3].
D Data from 1994, 1995 or 1996[2].

W: Walleye
NP: Northern pike
YP: Yellow perch
BB: Brown bullhead
LS: Lake sturgeon

CC: Channel catfish
WS: White sucker
LW: Lake whitefish
SB: Smallmouth bass

Shaded areas indicate values exceeding the federal fish marketing guideline (0.5 mg/kg).
Dashes indicate that none of the studies consulted contained data on this species for the years in question.

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MERCURY ACCUMULATION IN THE AQUATIC ENVIRONMENT

INORGANIC MERCURY occurs naturally in the environment. It is also introduced into the aquatic environment through various industrial, municipal and atmospheric discharges, and can accumulate in large quantities in sediment.

Inorganic mercury can become methylmercury when it comes in contact with the bacteria present in sediments. This organic compound is more easily assimilated by aquatic organisms such as fish and crustaceans, and it bioaccumulates all along the food chain. Contamination varies significantly from one fish species to another and depending on location. What's more, the mercury concentrated in fish tissue grows with the age and size of the fish. Piscivorous (fish-eating) fish are generally more contaminated than benthic organism eaters or insect eaters, mainly because of their diets.

The presence of mercury in its organic form in the aquatic ecosystem can inhibit photosynthesis and phytoplankton growth, leading to fish mortality or to reproductive failure. Mercury is highly toxic and small doses can be fatal to humans. "Long-term exposure to low levels of mercury can cause neurological damage, kidney damage and severe weight loss."[4] Since the early 1970s, better control of industrial-source mercury has slowed methylmercury contamination, but increasing atmospheric inputs mean we must remain vigilant.

It is difficult to establish a link between recorded contaminant concentrations in adult fish and a specific pollution source or sector because fish are so mobile. Nonetheless, we can still get an overall picture of contaminants in the ecosystem by examining adult fish, and analysis of their tissue is important for the protection of human consumers.

FISH SPECIES STUDIED

In 1994, the Brown bullhead, Yellow perch and Lake sturgeon represented 75% of the commercial freshwater catch. Piscivorous fish such as pike, Walleye and whitefish can grow to a considerable size. Bottom feeders (i.e., Brown bullhead, Channel catfish, White sucker and Lake sturgeon) eat benthic organisms such as molluscs, worms and insect larvae. Fish that eat mostly insect larvae, like Yellow perch, are typically small in size.

STANDARDS FOR HUMAN CONSUMPTION

Health Canada has set the guideline for fish products destined for market at a concentration of 0.5 mg/kg for mercury, and has issued recommendations on frequency of consumption. For fish harvested from the freshwater St. Lawrence, maximum recommended consumption varies from one to eight meals per month (a meal being equivalent to 230 grams of fresh fish). The figure varies according to fish species, size and catch site.[5] This consumption limit is based on the overall contamination levels of fish and consumers should consider all species eaten in a month.

Source
1. Paul, M., and D. Laliberté. 1988. *Teneurs en mercure, plomb, cadmium, BPC et pesticides organochlorés des sédiments et de la chair des poissons du fleuve Saint-Laurent et de la rivière des Outaouais en 1985.* Ministère de l'Environnement du Québec. Direction de la qualité du milieu aquatique. Rapport 86-07.
2. St. Lawrence Centre. 1996. Unpublished data. Environment Canada – Quebec Region.
3. Laliberté, D. 1996. *Teneurs en mercure et en composés organochlorés dans les poissons capturés au lac Aylmer en 1995.* Ministère de l'Environnement et de la Faune. Direction des écosystèmes aquatiques.
4. Government of Canada. 1991. "Toxic Chemicals: Cradle-to-Grave Management," in *The State of Canada's Environment.*
5. Ministère de la Santé et des Services sociaux and Ministère de l'Environnement et de la Faune. 1995. *Guide de consommation du poisson de pêche sportive en eau douce.*
6. Sloterdijk, H. 1977. *Accumulation des metaux lourds et des composés organochlorés dans la chair des poissons du fleuve Saint-Laurent.* Ministère du Tourisme, de la Chasse et de la Pêche, Comité d'étude sur le fleuve Saint-Laurent.

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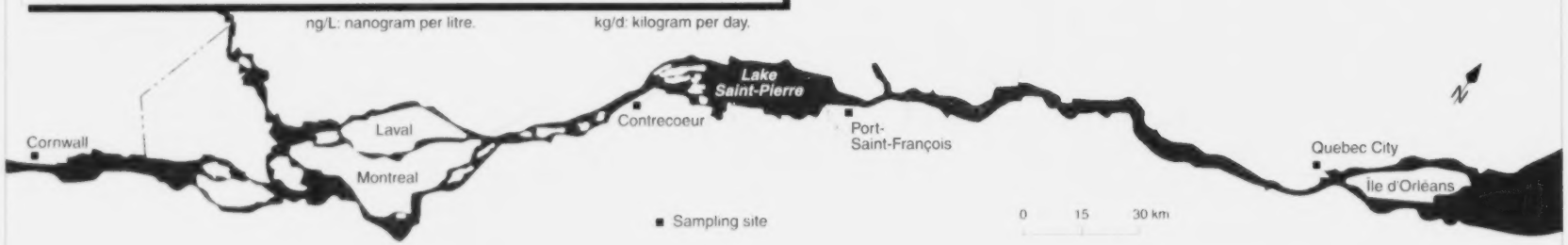

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Other sources (estimate)***	80	55	34

** Tributaries studied: Richelieu, Yamaska, Saint-François, Nicolet rivers.
*** Tributaries not studied, atmospheric deposition, surface runoff, sediment resuspension.

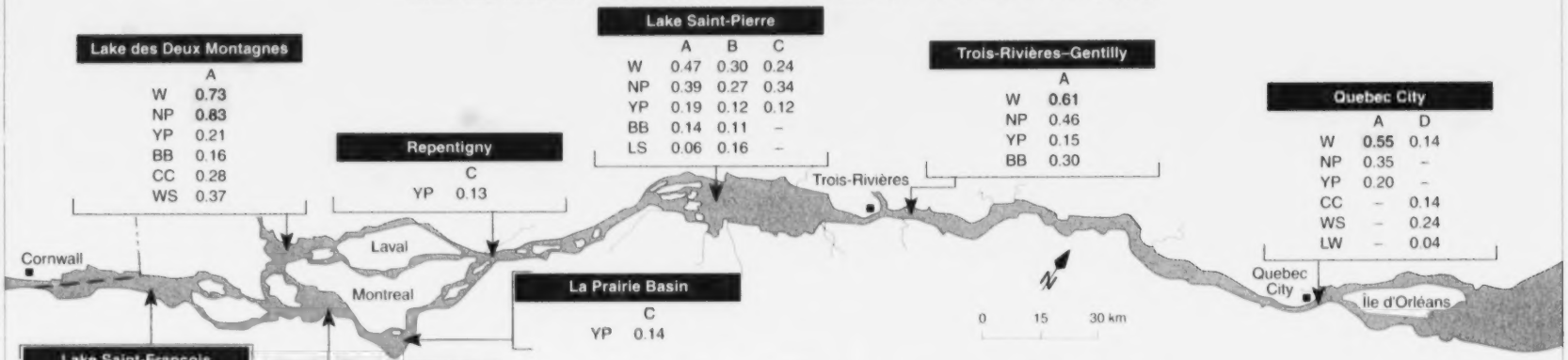
Note: Percentages were calculated in relation to the total diazinon measured at Quebec City.

Source: 1. Lemieux, C., B. Quémerais, and K.R. Lum. 1992. *Tendances temporelles de l'atrazine et du diazinon dans le fleuve Saint-Laurent et certains de ses tributaires.* Environment Canada, St. Lawrence Centre. Presented at the Canadian Association on Water Pollution Research and Control, 8th Eastern Region Conference.
2. Canadian Council of Resource and Environment Ministers. 1991. *Canadian Water Quality Guidelines.* Chapter 6.
3. SAGE Ltee. 1988. *Recueil des principaux pesticides en usage au Quebec. Vol. 1 – Rapport-synthese.* Prepared for Environment Canada.
4. Ministere de l'Environnement du Quebec. 1990. *Criteres de la qualite de l'eau.*

INFO-FLASH 65

The St. Lawrence River – Mercury Contamination of Adult Fish

AVERAGE MERCURY CONCENTRATION IN THE FLESH OF FRESHWATER FISH (mg/kg)



A Data from 1985[1].
B Data from 1989[2].
C Data from 1991, 1992 or 1993[2,3].
D Data from 1994, 1995 or 1996[2].

W: Walleye
NP: Northern pike
YP: Yellow perch
BB: Brown bullhead
LS: Lake sturgeon
CC: Channel catfish
WS: White sucker
LW: Lake whitefish
SB: Smallmouth bass

Shaded areas indicate values exceeding the federal fish marketing guideline (0.5 mg/kg).

Dashes indicate that none of the studies consulted contained data on this species for the years in question.

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MERCURY ACCUMULATION IN THE AQUATIC ENVIRONMENT

INORGANIC MERCURY occurs naturally in the environment. It is also introduced into the aquatic environment through various industrial, municipal and atmospheric discharges, and can accumulate in large quantities in sediment.

Inorganic mercury can become methylmercury when it comes in contact with the bacteria present in sediments. This organic compound is more easily assimilated by aquatic organisms such as fish and crustaceans, and it bioaccumulates all along the food chain. Contamination varies significantly from one fish species to another and depending on location. What's more, the mercury concentrated in fish tissue grows with the age and size of the fish. Piscivorous (fish-eating) fish are generally more contaminated than benthic organism eaters or insect eaters, mainly because of their diets.

The presence of mercury in its organic form in the aquatic ecosystem can inhibit photosynthesis and phytoplankton growth, leading to fish mortality or to reproductive failure. Mercury is highly toxic and small doses can be fatal to humans. "Long-term exposure to low levels of mercury can cause neurological damage, kidney damage and severe weight loss."[4] Since the early 1970s, better control of industrial-source mercury has slowed methylmercury contamination, but increasing atmospheric inputs mean we must remain vigilant.

It is difficult to establish a link between recorded contaminant concentrations in adult fish and a specific pollution source or sector because fish are so mobile. Nonetheless, we can still get an overall picture of contaminants in the ecosystem by examining adult fish, and analysis of their tissue is important for the protection of human consumers.

FISH SPECIES STUDIED

In 1994, the Brown bullhead, Yellow perch and Lake sturgeon represented 75% of the commercial freshwater catch. Piscivorous fish such as pike, Walleye and whitefish can grow to a considerable size. Bottom feeders (i.e., Brown bullhead, Channel catfish, White sucker and Lake sturgeon) eat benthic organisms such as molluscs, worms and insect larvae. Fish that eat mostly insect larvae, like Yellow perch, are typically small in size.

STANDARDS FOR HUMAN CONSUMPTION

Health Canada has set the guideline for fish products destined for market at a concentration of 0.5 mg/kg for mercury, and has issued recommendations on frequency of consumption. For fish harvested from the freshwater St. Lawrence, maximum recommended consumption varies from one to eight meals per month (a meal being equivalent to 230 grams of fresh fish). The figure varies according to fish species, size and catch site.[5] This consumption limit is based on the overall contamination levels of fish and consumers should consider all species eaten in a month.

Source:
1. Paul, M., and D. Laliberte. 1988. *Teneurs en mercure, plomb, cadmium, BPC et pesticides organochlorés des sédiments et de la chair des poissons du fleuve Saint-Laurent et de la rivière des Outaouais en 1985.* Ministère de l'Environnement du Québec. Direction de la qualité du milieu aquatique. Rapport 86-07.
2. St. Lawrence Centre. 1996. Unpublished data. Environment Canada – Quebec Region.
3. Laliberte, D. 1996. *Teneurs en mercure et en composés organochlorés dans les poissons capturés au lac Aylmer en 1995.* Ministère de l'Environnement et de la Faune. Direction des écosystèmes aquatiques.
4. Government of Canada. 1991. "Toxic Chemicals: Cradle-to-Grave Management," in *The State of Canada's Environment.*
5. Ministère de la Santé et des Services sociaux and Ministère de l'Environnement et de la Faune. 1995. *Guide de consommation du poisson de pêche sportive en eau douce.*
6. Sloterdijk, H. 1977. *Accumulation des métaux lourds et des composés organochlorés dans la chair des poissons du fleuve Saint-Laurent.* Ministère du Tourisme, de la Chasse et de la Pêche, Comité d'étude sur le fleuve Saint-Laurent.

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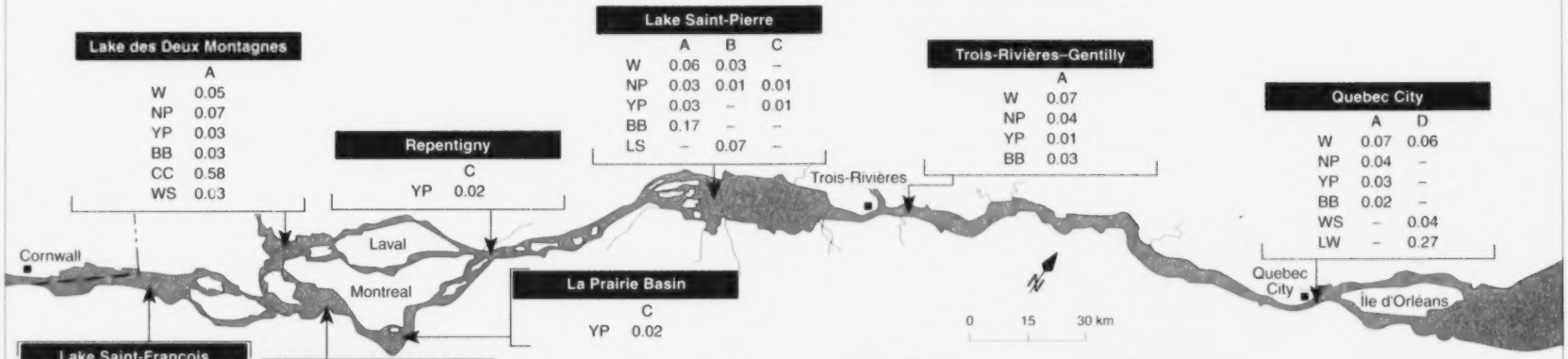
March 1997

The St. Lawrence River – PCB Contamination of Adult Fish

AVERAGE PCB CONCENTRATION IN THE FLESH OF FRESHWATER FISH (mg/kg)



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W: Walleye
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LS: Lake sturgeon
WS: White sucker
LW: Lake whitefish
CC: Channel catfish

No values shown here exceed the federal fish marketing guideline (2.0 mg/kg).
Dashes indicate that none of the studies consulted contained data on this species for the years in question.

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PCB ACCUMULATION IN THE AQUATIC ENVIRONMENT

PCBs ARE SYNTHESIZED ORGANOCHLORINES whose presence in the environment is due solely to human activity. The main sources of PCBs are industrial waste, leaching at contaminated sites, and the incineration of products containing PCBs. Even though they have been restricted for use in hydraulic and electrical equipment since 1980, PCBs are still found in varying concentrations in the aquatic environment.

PCBs are stable and insoluble in water, but highly soluble in fatty substances. In the aquatic environment, they basically concentrate on suspended solids and sediments. They are rapidly absorbed by aquatic organisms, where they accumulate specifically in fatty tissue. PCB concentrations in fish vary depending on the species and in relation to their trophic status (fish, benthic organism or insect eaters), their diets and the amount of fat in their tissue. Differences in PCB concentrations are possible even between species of the same trophic level, and can be explained by their fat content. Eel and sturgeon accumulate much larger amounts of PCBs than do Walleye or pike because they have more fat.

PCBs are toxic even in very low concentrations and may be lethal for certain aquatic animals such as fish. Typical symptoms of poisoning by PCBs include liver cancer and a lowering of the reproductive rate. Humans can suffer long-term health problems if they ingest PCBs in substantial and regular amounts via foods such as fish and seafood because these substances accumulate in the liver and fatty tissues. PCB poisoning in humans is manifested in deteriorating eyesight, hearing loss, skin lesions, neurological disorders and liver problems, among other things.

It is difficult to establish a link between recorded contaminant concentrations in adult fish and a specific pollution source or sector because fish are so mobile. Nonetheless, we can still get an overall picture of contaminants in the ecosystem by examining adult fish, and analysis of their tissue is important for the protection of human consumers.

FISH SPECIES STUDIED

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STANDARDS FOR HUMAN CONSUMPTION

Health Canada has set the guideline for fish products destined for market at a concentration of 2.0 mg/kg for PCBs, and has issued recommendations on frequency of consumption. For fish harvested from the freshwater St. Lawrence, maximum recommended consumption varies from one to eight meals per month (a meal being equivalent to 230 grams of fresh fish). The figure varies according to fish species, size and catch site.[4] This consumption limit is based on the overall contamination levels of fish and consumers should consider all species eaten in a month.

Source: 1. Paul, M., and D. Laliberté. 1988. *Teneurs en mercure, plomb, cadmium, BPC et pesticides organochlorés des sédiments et de la chair des poissons du fleuve Saint-Laurent et de la rivière des Outaouais en 1985.* Ministère de l'Environnement du Québec, Direction de la qualité du milieu aquatique. Rapport 86-07.
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The St. Lawrence River – Relative Importance of DDT (1990–91)

LOADS AND CONCENTRATIONS OF DDT IN THE RIVER (1990-91)[1]

	Cornwall		Contrecoeur		Port-Saint-François		Quebec City	
	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)	Concentration (ng/L)	Load (kg/d)
Summer 1990	0.602	0.454	0.926	0.709	1.030	0.730	0.462	0.390
Fall 1990	0.396	0.296	0.284	0.265	NA	NA	0.199	0.081
Spring 1991	0.534	0.429	1.215	0.974	1.484	1.020	0.951	0.638

NA: not analysed. ng/L: nanogram per litre. kg/d: kilogram per day.

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DDT (DICHLORODIPHENYL-TRICHLOROETHANE)

Pollution by toxic organic contaminants*

Production and use

DDT is an organochlorine insecticide that was widely used in the 1950s and 1960s to protect crops and trees from pests and to control rat populations. In 1964, worldwide production of DDT grew to 1.6 x 10^5 tonnes, 50% of which was made in the United States. A few years later,the negative effects of DDT on wildlife, coupled with fears of its risks for human health, led to tight restrictions on use of this product. In the early 1970s, DDT was either partially or completely banned in most western European countries and in North America. From 1979 to 1989, it was restricted for use in controlling bat and rat populations, and then only in cases where other products had failed. In Canada, DDT has not been registered for use since 1989, meaning its use is strictly forbidden. However, DDT is still being used in a number of developing countries (in South America, and in China and India).

Main sources today

The main existing sources of DDT are residual traces of applications that predate the ban on its use in Canada, and atmospheric deposition from various regions of the world where DDT use is still permitted. Aerial spraying of this product has greatly contributed to its introduction into the aquatic environment.

Characteristics and potential effects

Although DDT is very stable, some time after its application it becomes two derivatives: DDE and DDD, which are even more persistent than DDT in its original form. Due to their chemical properties (persistence, water-insoluble, fat-soluble), DDT and its derivatives tend to accumulate in sediment and to be rapidly absorbed by organisms in the aquatic environment, where they are bioaccumulated and bioconcentrated. Numerous studies on DDT have provided clear and irrefutable evidence of the chemical's harmful effects on wildlife. In regions where DDT was widely used, its disastrous effects on fish and birds (deformities, thinning eggshells, reproductive failure) have been recorded. Invertebrates are generally more sensitive to DDT than are fish.

Quality criteria of the Ministère de l'Environnement du Québec (1990):

- Raw water (domestic water intake) and contamination of aquatic organisms: 0.024 ng/L
- Aquatic life (chronic toxicity): 1 ng/L
- Aquatic life (acute toxicity): 1100 ng/L (fresh water) and 130 ng/L (salt water).

* Refers to Info-Flash fact sheet 51 on types of pollution.

DDT IN THE ST. LAWRENCE RIVER, BY SOURCE, MAY 1991
(calculated in water and suspended solids)

Source	%
Tributaries (DDT measured in 5 major tributaries)**	33
Great Lakes (DDT measured at Cornwall)	32
Atmospheric deposition (estimate)	4
Other sources (estimate)***	31

** Tributaries studied: Richelieu, Yamaska, Saint-François, Nicolet and Ottawa rivers.
*** Tributaries not studied, surface runoff and soil erosion (especially in farming regions).

Note: Percentages were calculated in relation to total DDT measured at Quebec City.
DDT compounds studied: o,p'-DDT; p,p'-DDT.

Source:
1. Pham, T., K. Lum, and C. Lemieux. 1993. The occurrence, distribution and sources of DDT in the St. Lawrence River (Canada), *Chemosphere* 26(9): 1596-1606.
2. Canadian Council of Resource and Environment Ministers. 1991. *Canadian Water Quality Guidelines*.
3. Ministère de l'Environnement du Québec. 1990. *Critères de la qualité de l'eau*.

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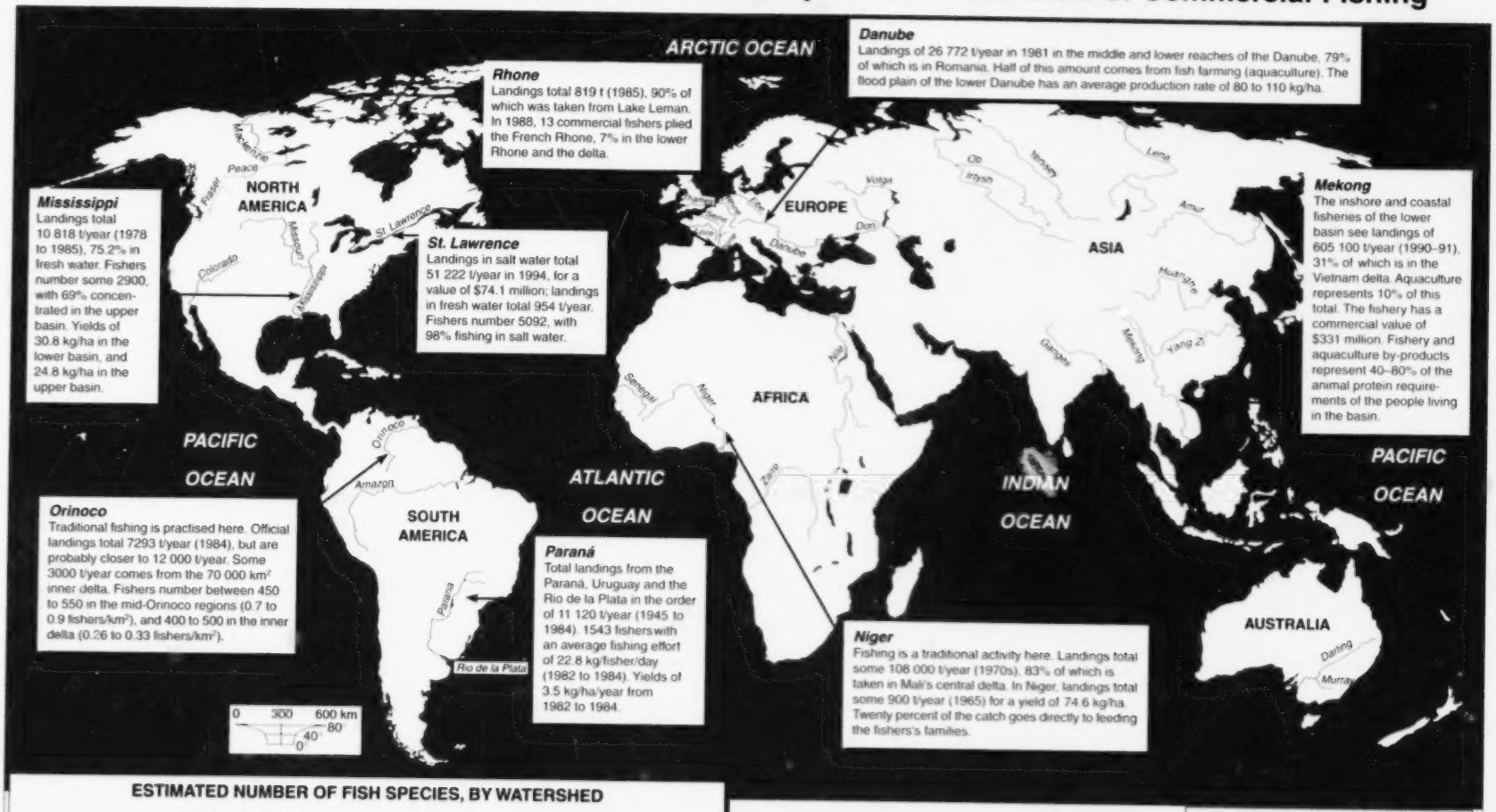
The St. Lawrence Compared to Other Major Rivers: Overview of Commercial Fishing



Mississippi
Landings total 10 818 t/year (1978 to 1985), 75.2% in fresh water. Fishers number some 2900, with 69% concentrated in the upper basin. Yields of 30.8 kg/ha in the lower basin, and 24.8 kg/ha in the upper basin.

Rhone
Landings total 819 t (1985), 90% of which was taken from Lake Leman. In 1988, 13 commercial fishers plied the French Rhone, 7% in the lower Rhone and the delta.

St. Lawrence
Landings in salt water total 51 222 t/year in 1994, for a value of $74.1 million; landings in fresh water total 954 t/year. Fishers number 5092, with 98% fishing in salt water.

Danube
Landings of 26 772 t/year in 1981 in the middle and lower reaches of the Danube, 79% of which is in Romania. Half of this amount comes from fish farming (aquaculture). The flood plain of the lower Danube has an average production rate of 80 to 110 kg/ha.

Mekong
The inshore and coastal fisheries of the lower basin see landings of 605 100 t/year (1990–91), 31% of which is in the Vietnam delta. Aquaculture represents 10% of this total. The fishery has a commercial value of $331 million. Fishery and aquaculture by-products represent 40–80% of the animal protein requirements of the people living in the basin.

Orinoco
Traditional fishing is practised here. Official landings total 7293 t/year (1984), but are probably closer to 12 000 t/year. Some 3000 t/year comes from the 70 000 km² inner delta. Fishers number between 450 to 550 in the mid-Orinoco regions (0.7 to 0.9 fishers/km²), and 400 to 500 in the inner delta (0.26 to 0.33 fishers/km²).

Paraná
Total landings from the Paraná, Uruguay and the Rio de la Plata in the order of 11 120 t/year (1945 to 1984). 1543 fishers with an average fishing effort of 22.8 kg/fisher/day (1982 to 1984). Yields of 3.5 kg/ha/year from 1982 to 1984.

Niger
Fishing is a traditional activity here. Landings total some 108 000 t/year (1970s), 83% of which is taken in Mali's central delta. In Niger, landings total some 900 t/year (1965) for a yield of 74.6 kg/ha. Twenty percent of the catch goes directly to feeding the fishers's families.

ESTIMATED NUMBER OF FISH SPECIES, BY WATERSHED

River	Number of species of fish	Species specifics
Amazon	2000	30 percent have yet to be described
Colorado	100	33 indigenous, 67 introduced
Danube	100	30 commercially valuable
Fraser	63	47 freshwater, 36 marine, 14 commercially valuable
Ganges	141	–
Mackenzie	53	Only indigenous species
Mississippi–Missouri	306	260 freshwater, 46 marine, 10 commercially valuable
Murray	50	39 indigenous, 11 introduced
Orinoco	318	60 commercially valuable
Rhine	61	44 indigenous, 16 introduced
Rhone	70	–
St. Lawrence	**185**	**87 freshwater, 98 marine or diadromous, 47 commercially valuable**
Senegal	113	Freshwater species only
Volga	88	74 indigenous, 14 introduced

ANNUAL FISH AND SEAFOOD CONSUMPTION IN 1985 (kg/inhab.)*

Germany	6.4	Japan	37.2
Australia	8.1	Netherlands	10.4
Austria	4.9	Portugal	39.8
Canada	**7.2**	United Kingdom	15.0
Denmark	45.6	Sweden	17.4
United States	7.1	Switzerland	7.0
France	17.9	Turkey	7.3

* Consumption is expressed in edible weight; that is, in the net weight of marine products, obtained by subtracting those parts not typically eaten (shell, scales, skin, head, bone, viscera).

The rivers selected to overview commercial fishing in fluvial watersheds are those for which we had data at the time this fact sheet was being prepared.

St. Lawrence Centre
State of the Environment

Saint-Laurent Vision 2000

Source: • Organization for Economic Cooperation and Development (OECD). 1988. *Statistiques de la consommation des denrées alimentaires*. Paris: OECD Publications.
• Fisheries and Oceans. 1989. *Proceedings of the International Large River Symposium (LARS)*. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

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March 1997

The St. Lawrence River – Sedimentation of Fluvial Lakes

FLUVIAL LAKES AND SEDIMENTATION

Moving from upstream to downstream between Cornwall and Quebec City, the St. Lawrence River widens to form three fluvial lakes: Saint-François, Saint-Louis and Saint-Pierre. These lakes contain two independent, lateral water masses, separated by a central zone (main channel). Most of the river flows through this middle zone, without interference from the lateral sections. Current speed generally reaches 2 to 3 m/s in the main channel, and between 0.05 and 0.2 m/s in the lateral water masses, where the water is retained for between 2 and 12 days, depending on the lake.

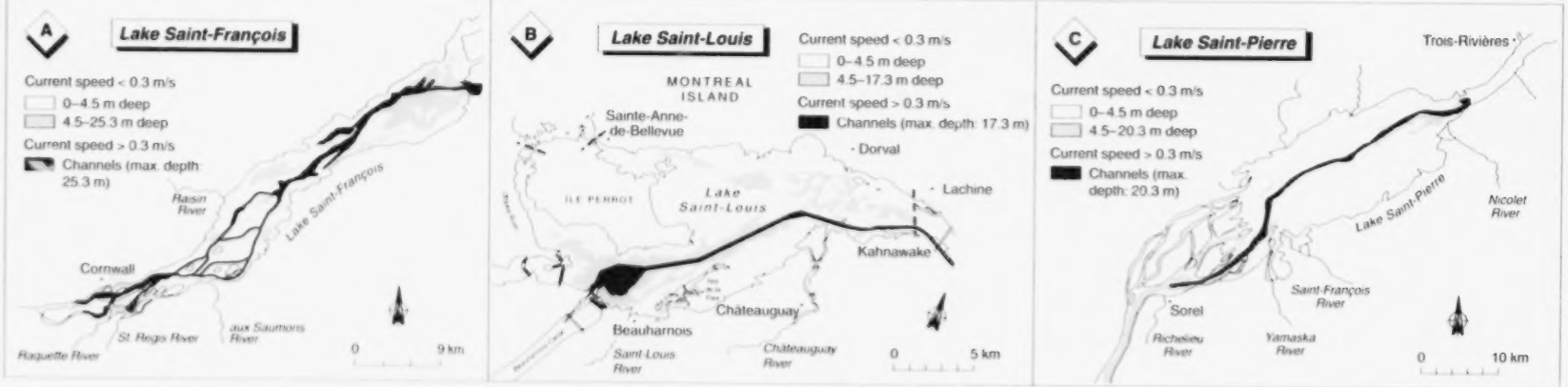
According to a study by Carignan et al. (1993) on the sedimentary dynamics of fluvial lakes, 11 of the 23 sites studied on these three lakes showed net accumulations of sediment. The rate of sediment accumulation varies within each lake and from one lake to another. Sedimentation accounts for between 4–8% of the total annual load moving through Lake Saint-François; for 1% in Lake Saint-Louis; and for 3% in Lake Saint-Pierre. In the stretch between Cornwall and Trois-Rivières, sedimentation represents about 6% of the total mass of suspended solids deposited at Trois-Rivières (4 800 00 t/yr).

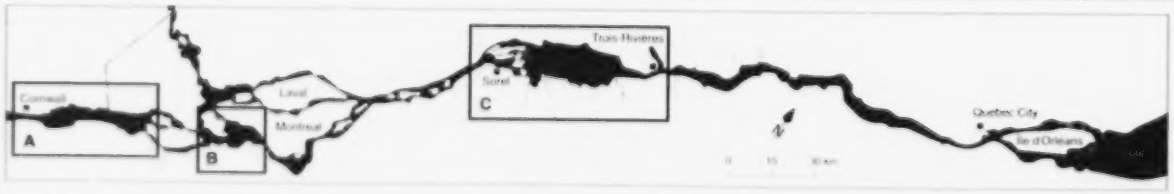
CHARACTERISTICS OF THE FLUVIAL LAKES

	Area (km²)			Size (km²) of sediment net accumulation zones***	Average depth (m)	Retention time of water masses in lateral sections (days)	Average sediment net accumulation (silt and clay only)		
	Zones (channel banks)*	Channels**	Total				cm/yr	kg/m²	tonnes/yr
Saint-François	176	59	235	28	5.1	12.0	0.14 to 1.66	3.2	90 000
Saint-Louis	105	35	140	15	3.4	1.9	0.59 to 1.16	3.1	47 000
Saint-Pierre	249	153	402	18	2.7	3.2	1.2	8.9	160 000

* Zones where current speeds are < 0.3 m/s.
** Zones where current speeds are > 0.3 m/s.
*** Zones where depths are > 4.5 m. They are included in the channel bank zones.

BATHYMETRY AND ZONES OF SEDIMENT ACCUMULATION* IN FLUVIAL LAKES





* Sediment generally accumulates at sites that are deeper than 4.5 m and located outside of a main channel. These zones are shown as shaded areas in the above maps.

Source: Carignan, R., S. Lorrain and K.R. Lum. 1993. Sediment dynamics in the fluvial lakes of the St. Lawrence River: Accumulation rates, and residence time of mobile sediments. Submitted to *Geochimica et Cosmochimica Acta*.

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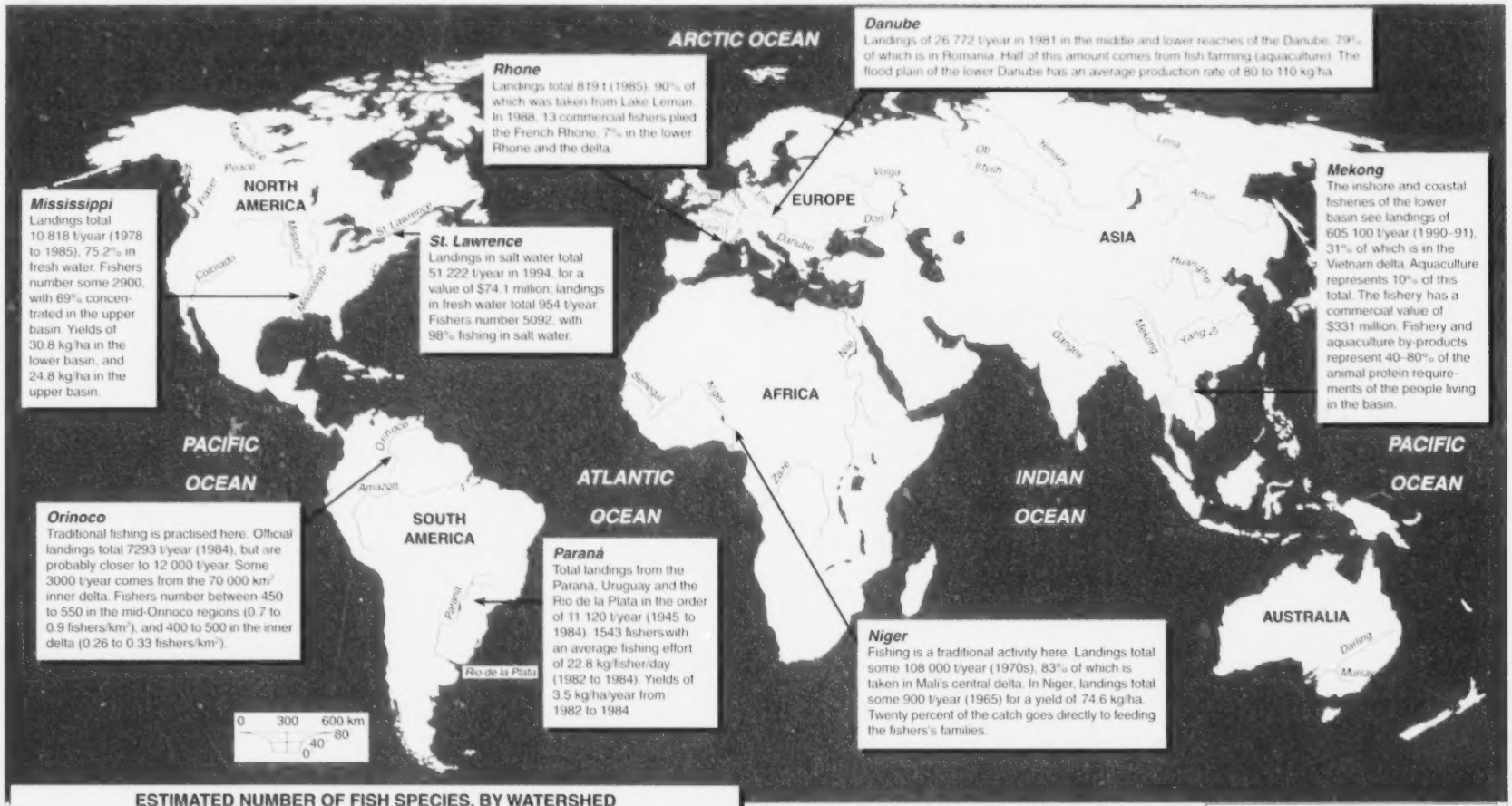
March 1997

INFO-FLASH 68

The St. Lawrence Compared to Other Major Rivers: Overview of Commercial Fishing



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Source: • Organization for Economic Cooperation and Development (OECD). 1988. *Statistiques de la consommation des denrées alimentaires*. Paris: OECD Publications.
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March 1997

The St. Lawrence River – Sedimentation of Fluvial Lakes

FLUVIAL LAKES AND SEDIMENTATION

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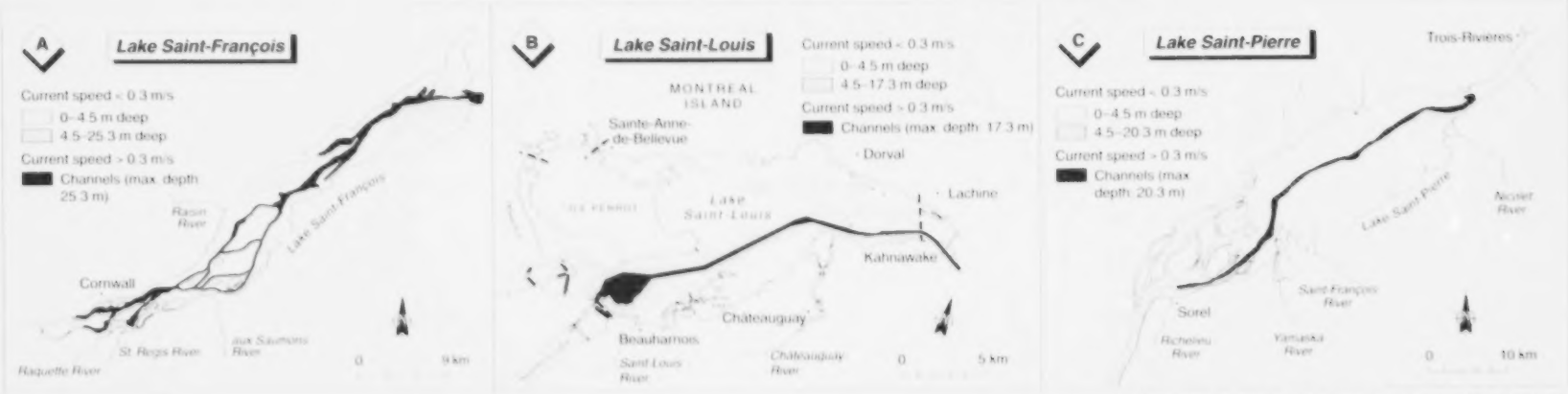
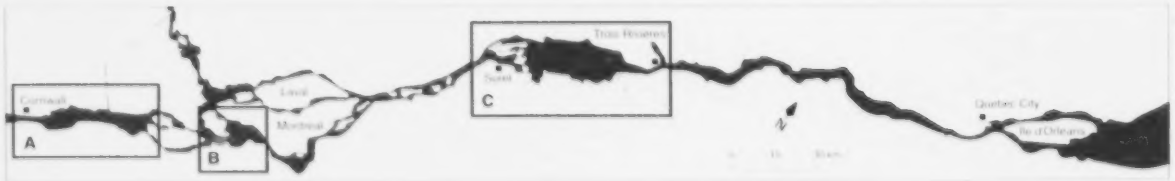
	Zones (channel banks)*	Channels**	Total				cm/yr	kg/m²	tonnes/yr
Saint-François	176	59	235	28	5.1	12.0	0.14 to 1.66	3.2	90 000
Saint-Louis	105	35	140	15	3.4	1.9	0.59 to 1.16	3.1	47 000
Saint-Pierre	249	153	402	18	2.7	3.2	1.2	8.9	160 000

* Zones where current speeds are < 0.3 m/s.
** Zones where current speeds are > 0.3 m/s.
*** Zones where depths are > 4.5 m. They are included in the channel bank zones.

BATHYMETRY AND ZONES OF SEDIMENT ACCUMULATION* IN FLUVIAL LAKES





* Sediment generally accumulates at sites that are deeper than 4.5 m and located outside of a main channel. These zones are shown as shaded areas in the above maps.

Source: Carignan, R., S. Lorrain and K.R. Lum. 1993. Sediment dynamics in the fluvial lakes of the St. Lawrence River: Accumulation rates, and residence time of mobile sediments. Submitted to *Geochimica et Cosmochimica Acta*.

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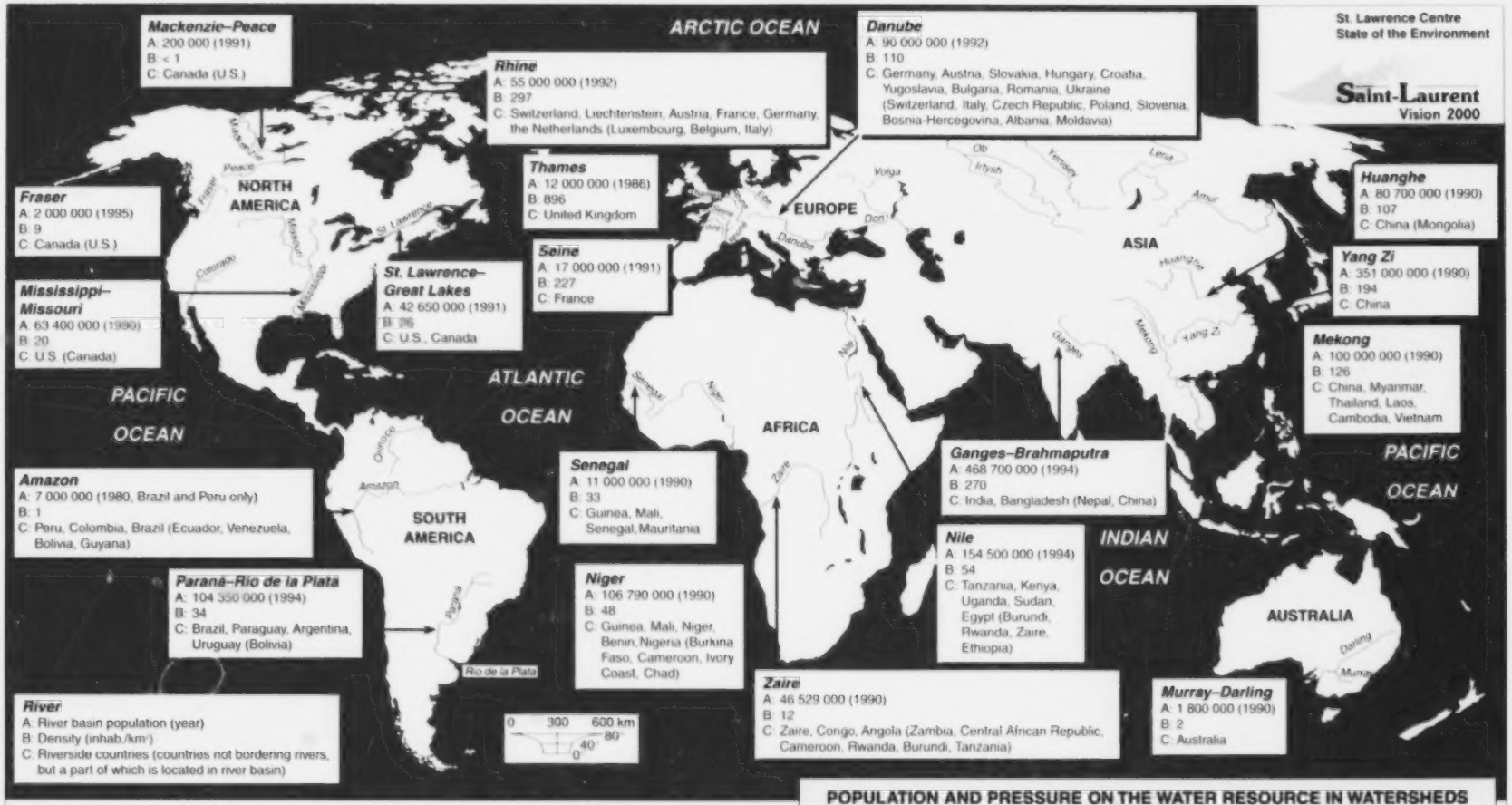
The St. Lawrence Compared to Other Major Rivers: Pressure on the Water Resource



INDICATORS OF PRESSURE ON THE WATER RESOURCE, BY WATERSHED

River	Pressure (inhab. per m³/s)	Availability (m³/yr per inhab.)	River	Pressure (inhab. per m³/s)	Availability (m³/yr per inhab.)
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Danube	13 646	2 310	Nile	36 133	873
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Mississippi–Missouri	3 522	8 953	Thames	134 000	235
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The St. Lawrence River – Contamination of Sediment in Lake Saint-François (1990)

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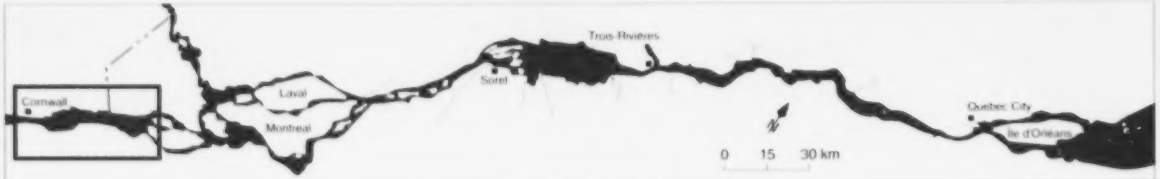
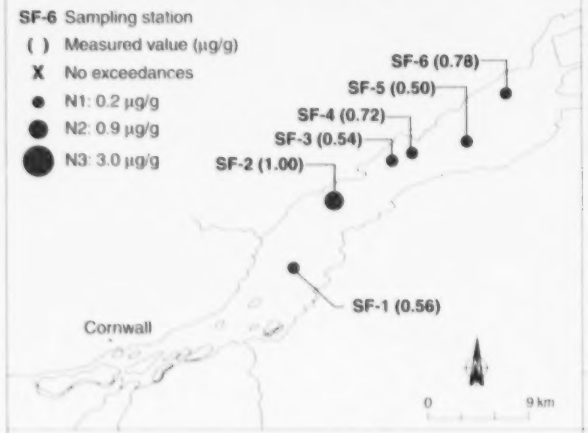


CRITERIA EXCEEDANCES FOR CADMIUM



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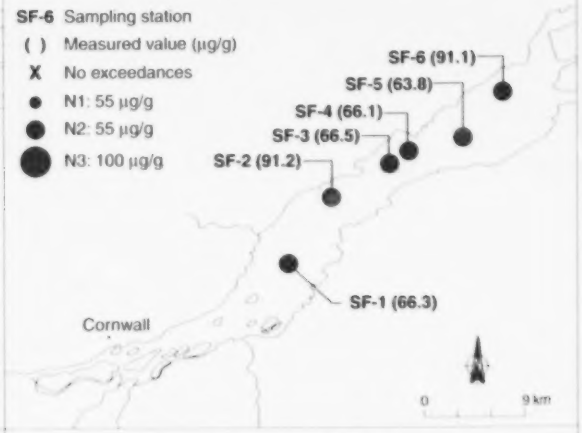

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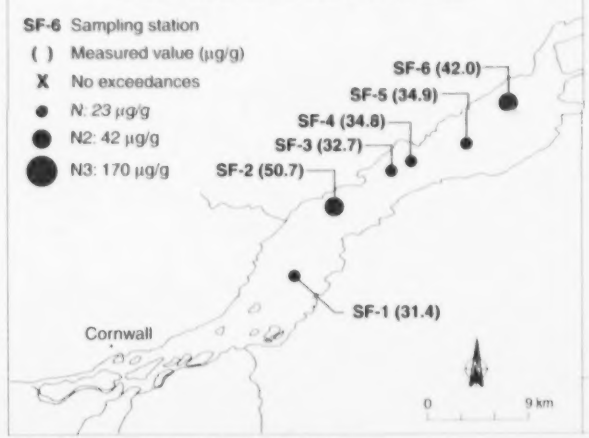
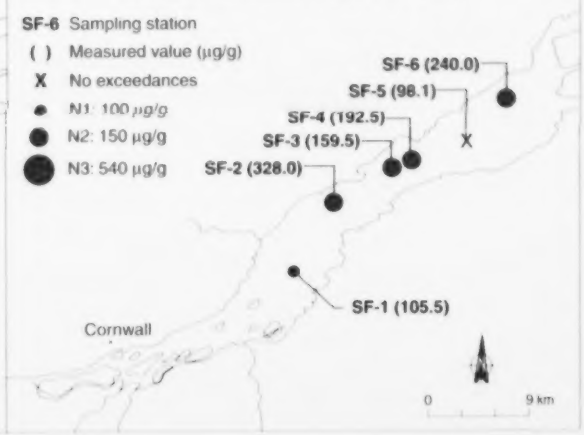


CRITERIA EXDEEDANCES FOR ZINC



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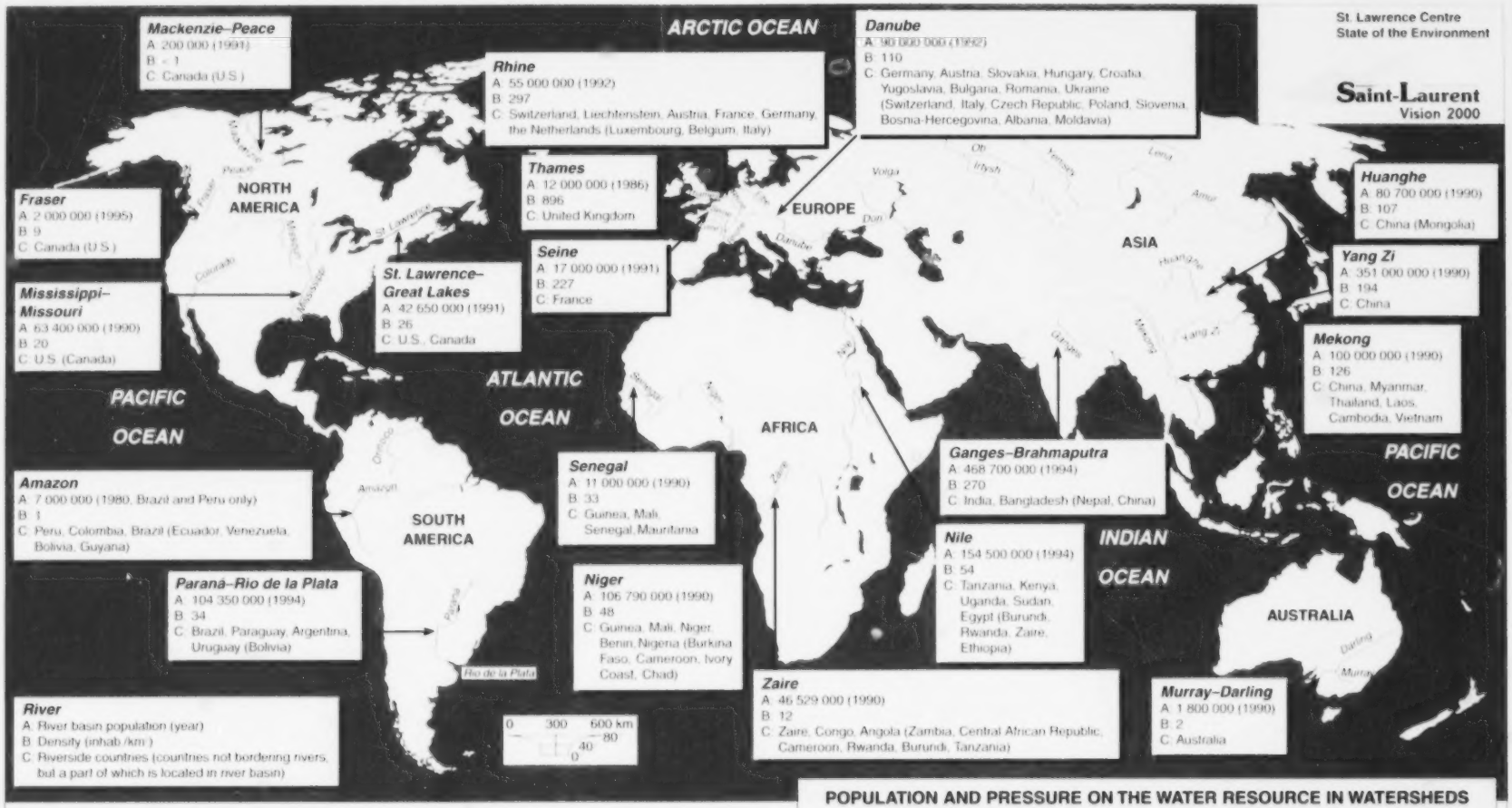
The St. Lawrence Compared to Other Major Rivers: Pressure on the Water Resource



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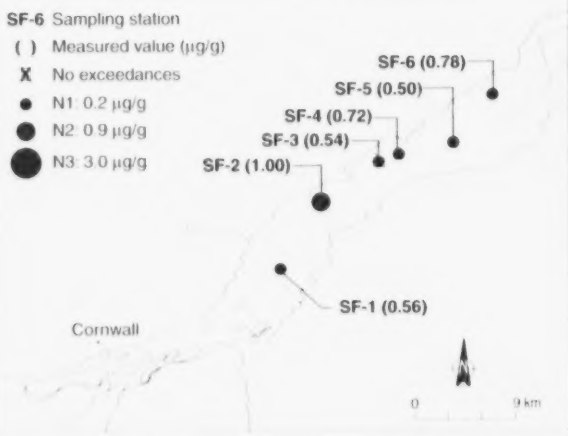
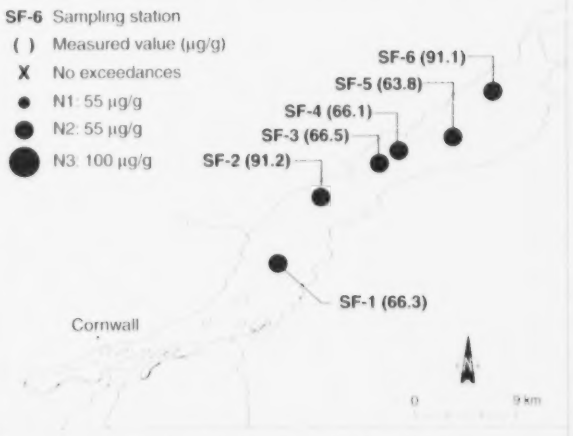
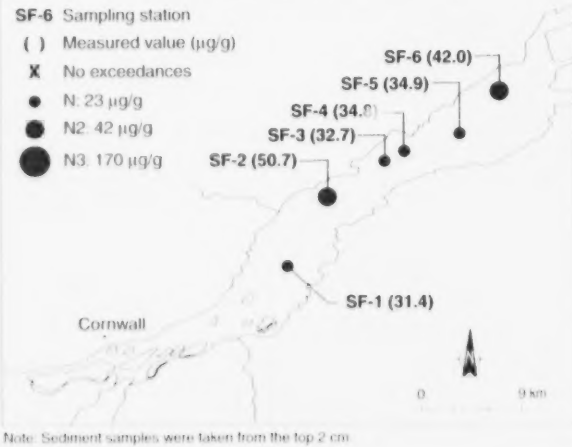
CRITERIA EXCEEDANCES FOR CADMIUM



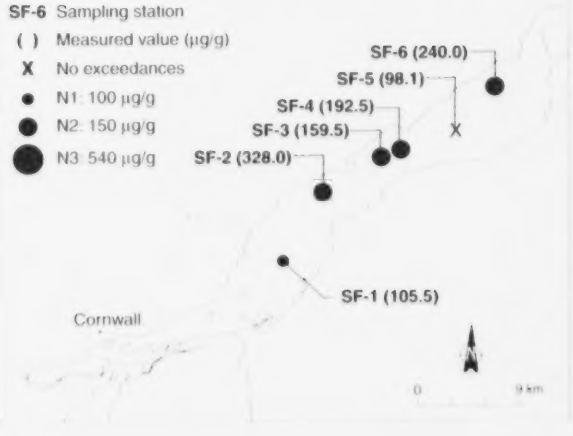
CRITERIA EXCEEDANCES FOR CHROMIUM



CRITERIA EXCEEDANCES FOR LEAD



CRITERIA EXDEEDANCES FOR ZINC



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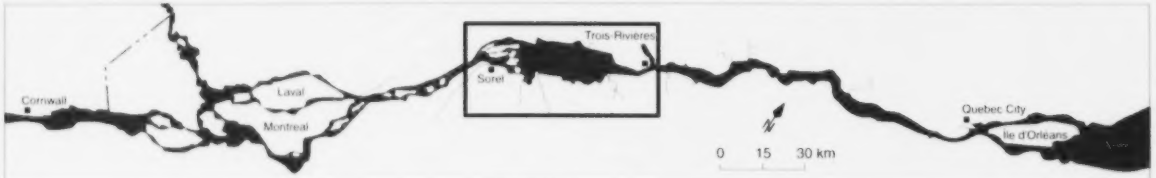

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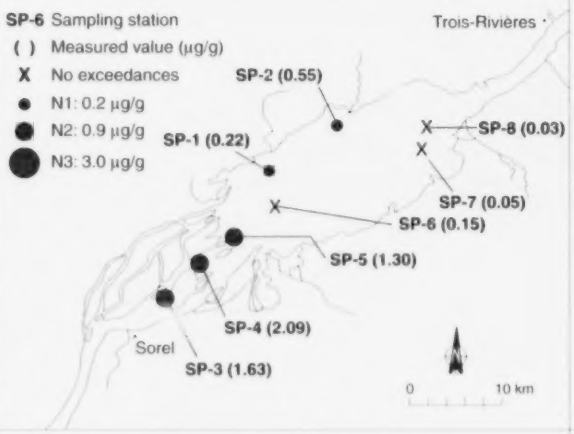

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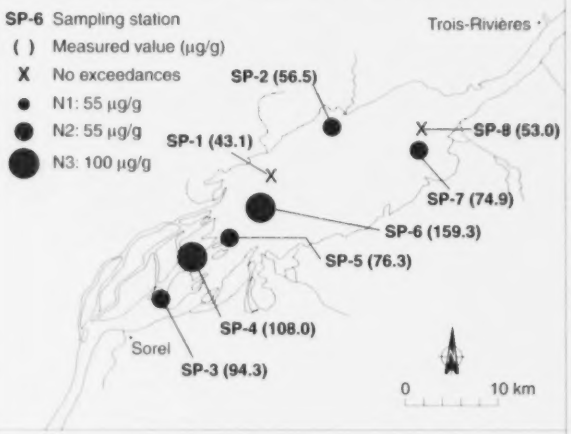

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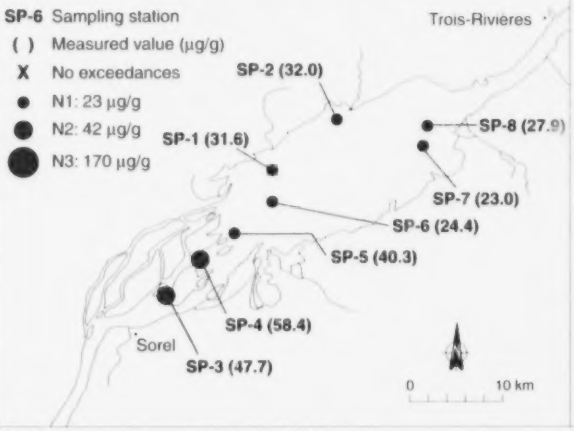

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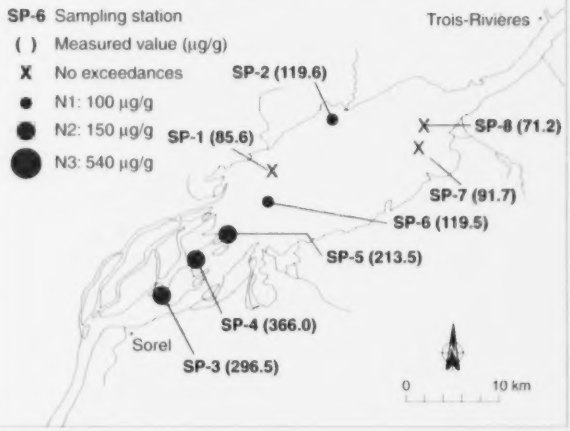

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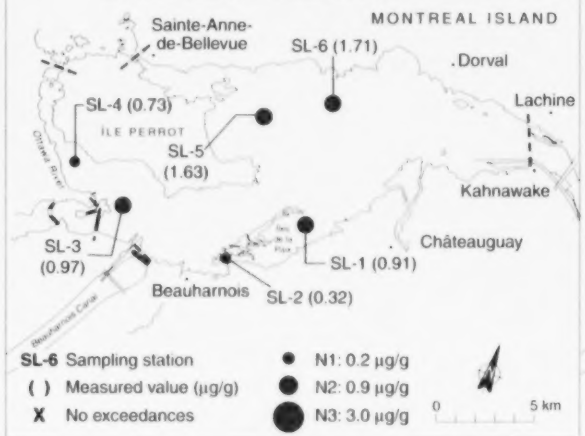

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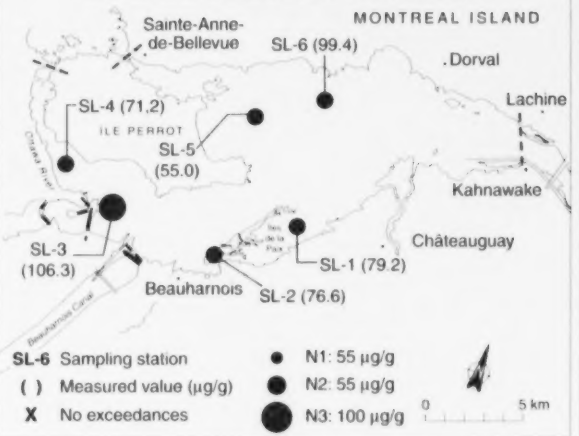

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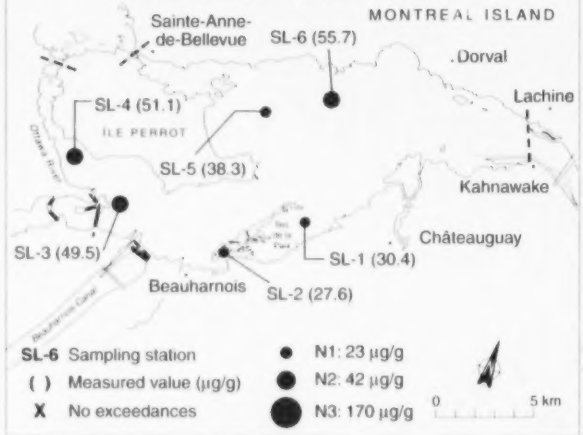

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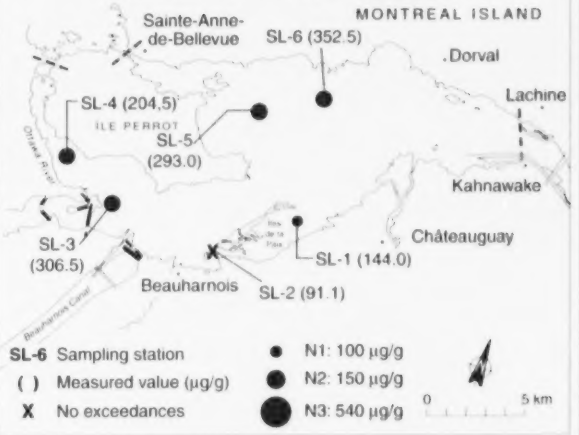

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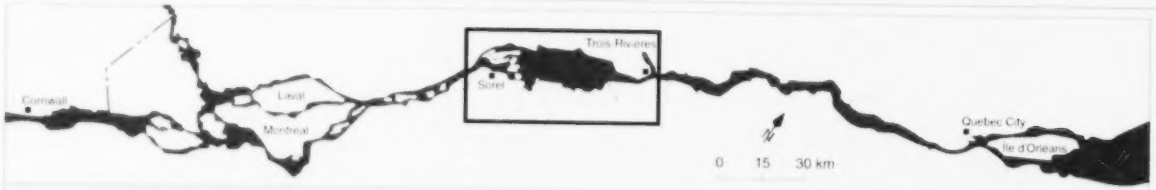

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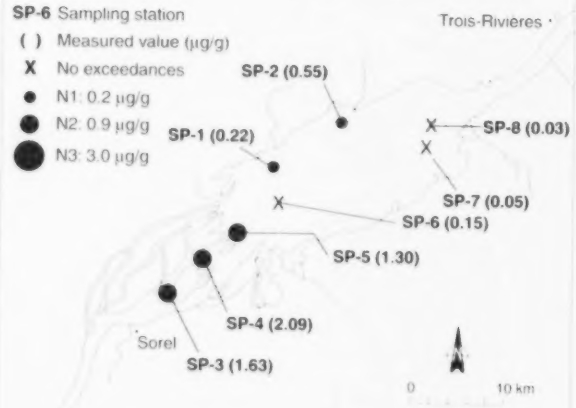

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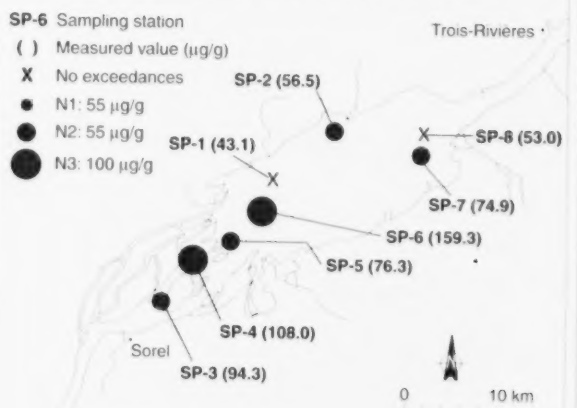

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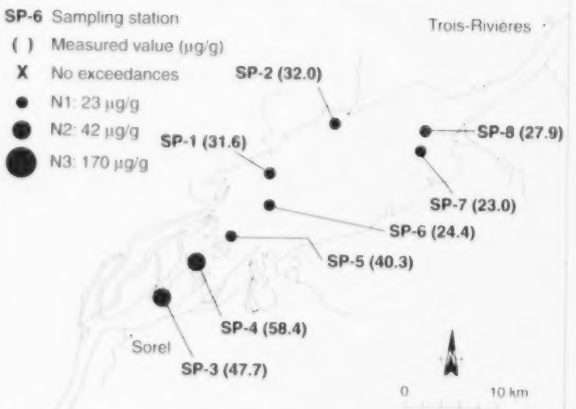

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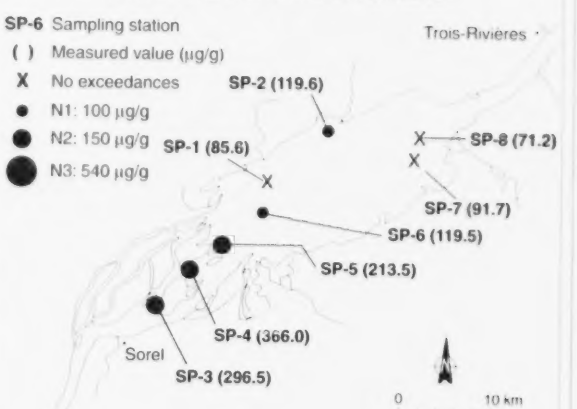

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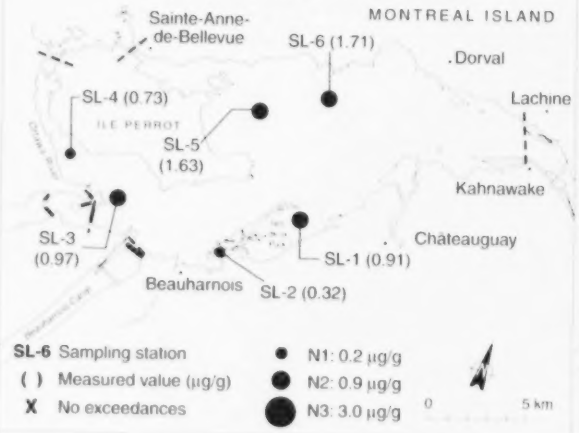
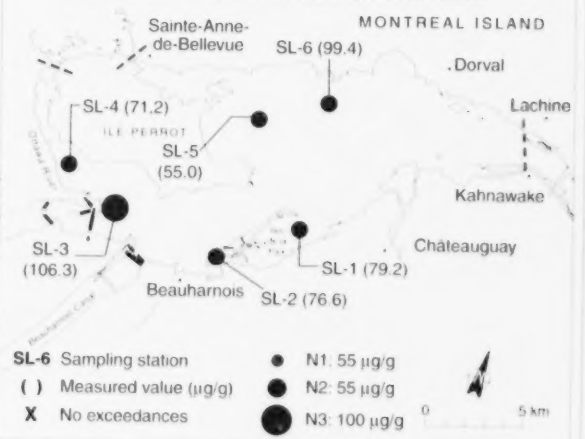
N3 Toxic Effect Threshold: Critical concentration above which major harm is done to benthic organisms. A level of contamination that affects 90% of benthic organisms.

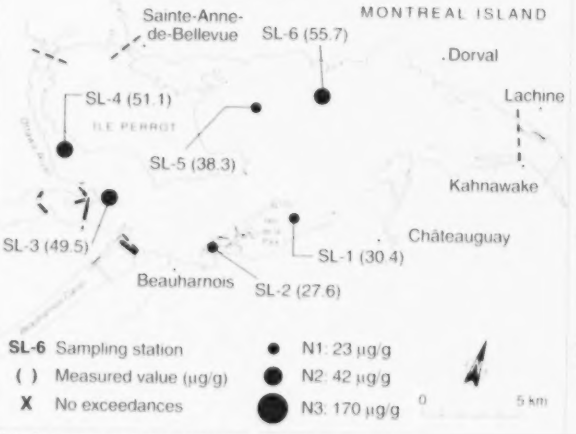
CRITERIA EXCEEDANCES FOR CADMIUM



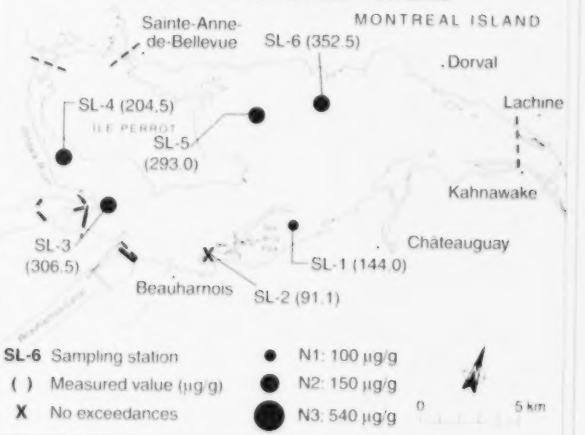
CRITERIA EXCEEDANCES FOR CHROMIUM



CRITERIA EXCEEDANCES FOR LEAD



CRITERIA EXCEEDANCES FOR ZINC



Note: Sediment samples were taken from the top 2 cm.

Source: 1. Environment Canada and the Ministère de l'Environnement du Québec. 1992. *Interim Criteria for Quality Assessment of St. Lawrence River Sediment*. St. Lawrence Centre.
2. Lorrain, S. 1993. Unpublished data on sediment contamination by trace metals. Environment Canada, St. Lawrence Centre.

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The St. Lawrence River – Toxic Potential of Action Plan Priority Plant Effluents

POTENTIAL ECOTOXIC EFFECTS PROBE (PEEP)

THE PEEP IS A SCIENTIFIC MANAGEMENT tool which uses a single scale of toxicity to assess and compare the potential biological effects of the toxics contained in the industrial effluent of the 50 St. Lawrence Action Plan priority plants. A PEEP is determined based on a group of five bioassays (biological tests). The potential toxic effects of these industrial effluents are determined by exposing aquatic organisms from three trophic levels (bacteria, algae, crustaceans) to samples of these effluents.

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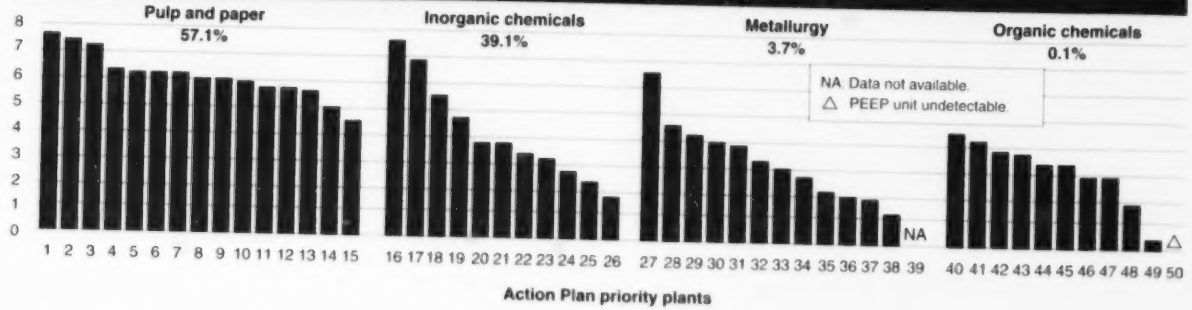
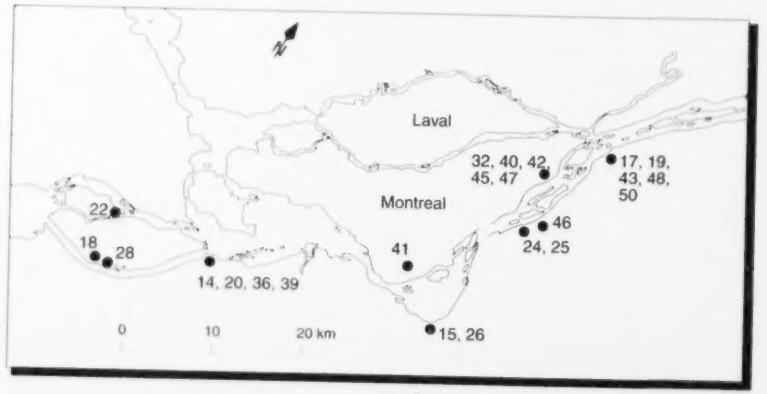
RELATIVE IMPORTANCE OF THE TOXIC POTENTIAL OF 50 ACTION PLAN PRIORITY PLANTS BY INDUSTRIAL SECTOR (1989-1992)

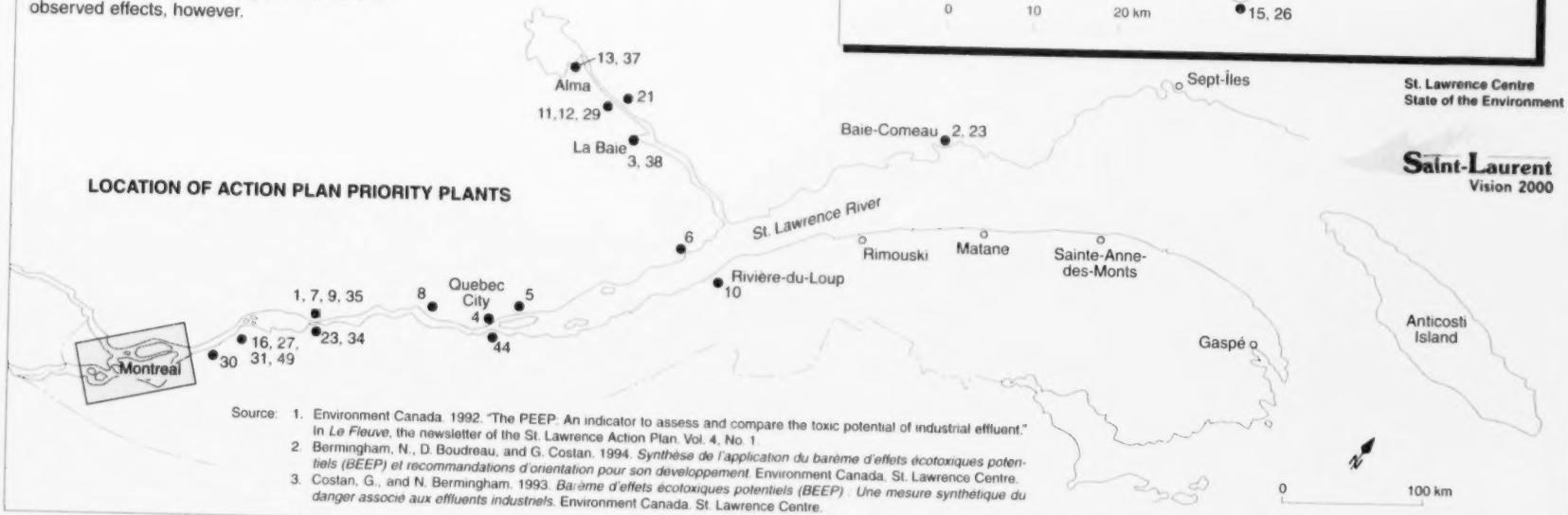


RELATIVE CONTRIBUTION OF INDUSTRIAL SECTORS

The results of the first assessment of effluent from the 50 Action Plan plants indicate that the pulp and paper sector has the highest relative input (57.1%), followed by the inorganic chemical sector (39.1%), the metallurgy sector (3.7%) and, lastly, the organic chemical sector (0.1%).



LOCATION OF ACTION PLAN PRIORITY PLANTS



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Source:
1. Environment Canada. 1992. "The PEEP. An indicator to assess and compare the toxic potential of industrial effluent." In *Le Fleuve*, the newsletter of the St. Lawrence Action Plan. Vol. 4, No. 1.
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The St. Lawrence River – Reduction in Toxic Discharges at Action Plan Industrial Plants (1988–1995)

CHIMIOTOX INDEX

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Chimiotox is a mathematical indicator based in quantitative and toxicological considerations. It is used to assess the relative importance of the toxic substances discharged in a given effluent. It does not take into account the capacity of a receiving environment, nor its acidity, nor the individual effects of each of these substances, nor conventional parameters such as suspended solids (SS) content or biochemical oxygen demand (BOD_5). Daily amounts of each substance measured were converted into Chimiotox Units (CU) using a toxic weighting factor (F_{tox}) specific to each pollutant. This factor is the weighting assigned a pollutant to assess its relative importance in the discharge, and was developed for each polluting substance based on the most stringent water quality criterion. The individual Chimiotox Units of each substance are then added together to determine the effluent's Chimiotox Index (CI) for the substances analysed. The higher the Chimiotox Index, the greater the toxic discharge, either in terms of quantity or toxicity.

$$CU_A = Load_A \times F_{toxA}$$

$$CI_{effluent} = CU_A + CU_B + CU_C + \ldots + CU_Z$$

where

CU_A: Chimiotox Unit of pollutant A in effluent.

$Load_A$: Quantity of pollutant A discharged in a single day in the effluent, in kilograms per day.

F_{toxA}: Toxic weighting factor of pollutant A.

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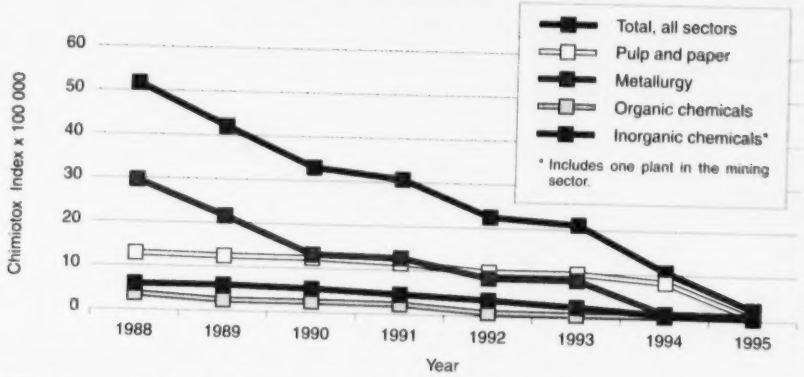
CHIMIOTOX INDEX

Total toxic discharges of the 50 Action Plan priority plants, by industrial sector



Toxic parameters used to calculate the Chimiotox Index (CI)

Some 35 inorganic parameters: heavy metals, other metals, anions and others.

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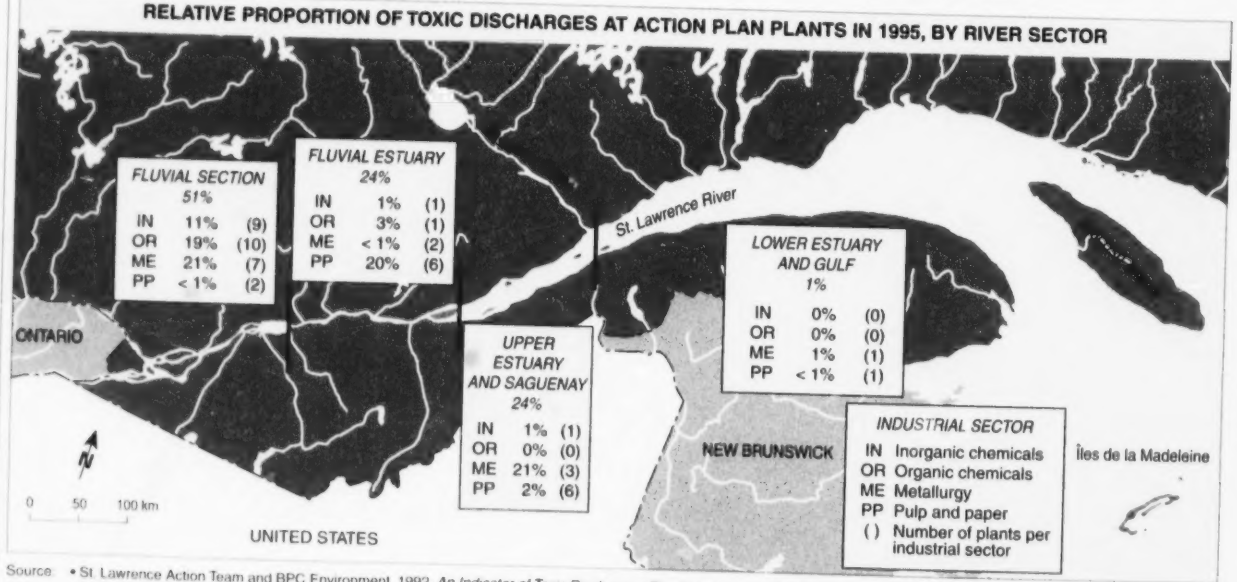

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	Reduction (%)			
Sector	**1989**	**1991**	**1993**	**1995**
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Metallurgy (13)	27	57	72	97
Pulp and paper (15)	3	10	23	96
Total (50 plants)	**19**	**41**	**59**	**96**

Seven plants have interrupted their activities since the start of the program in 1988. Two of these same have since resumed their operations.

The closure of five plants has contributed about 2% to the total reduction of toxic discharges.

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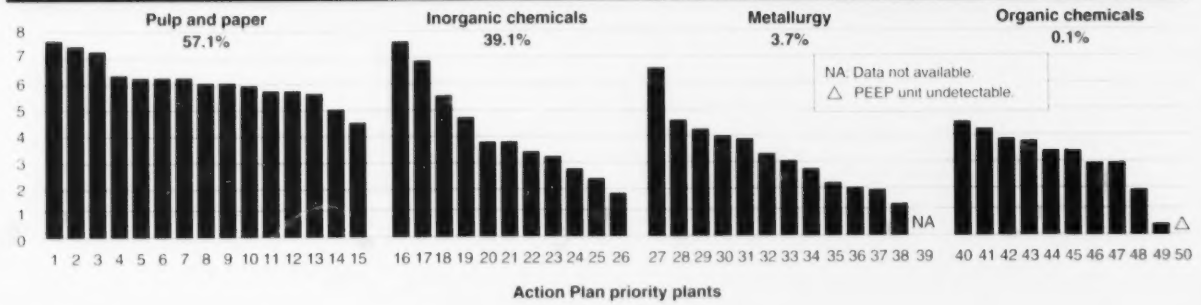

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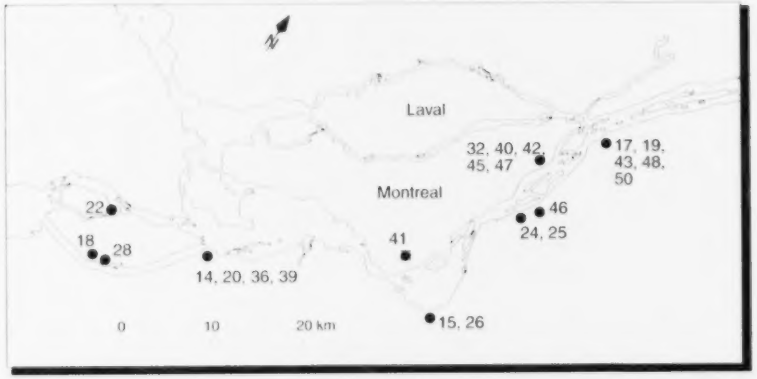

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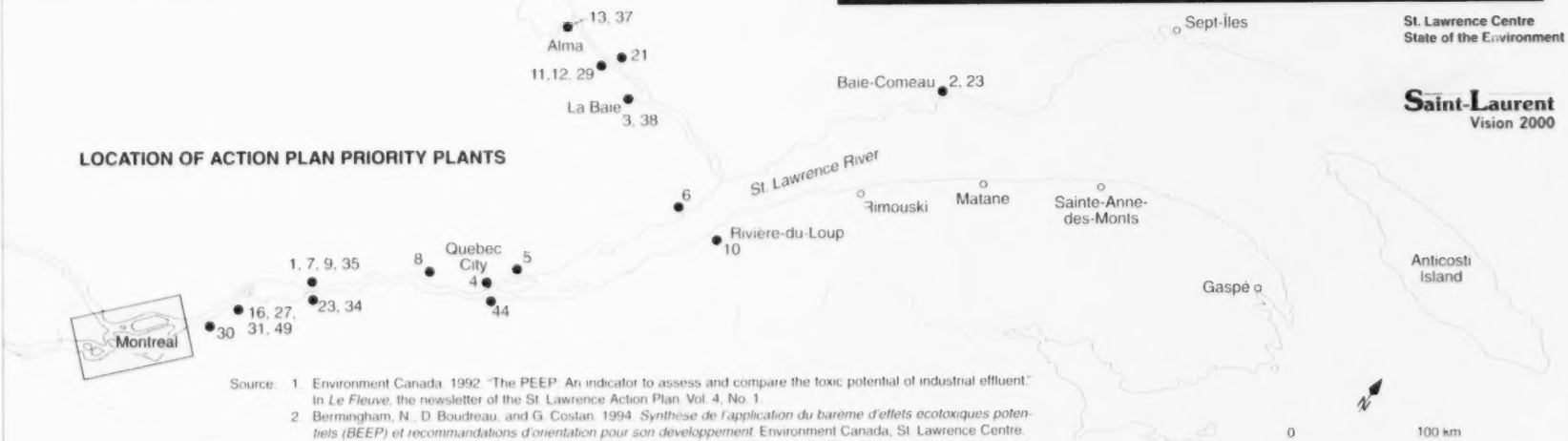

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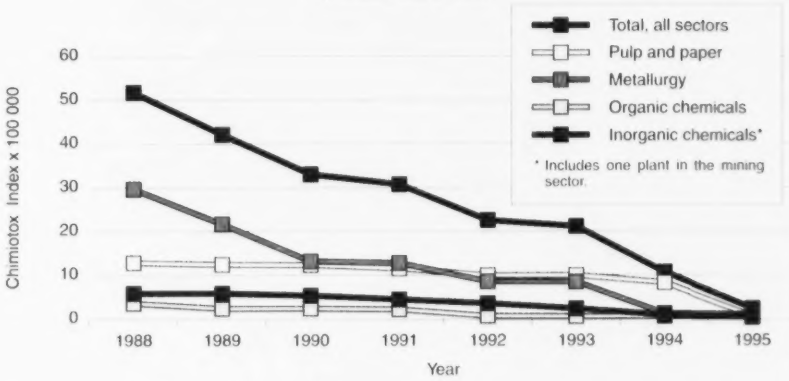

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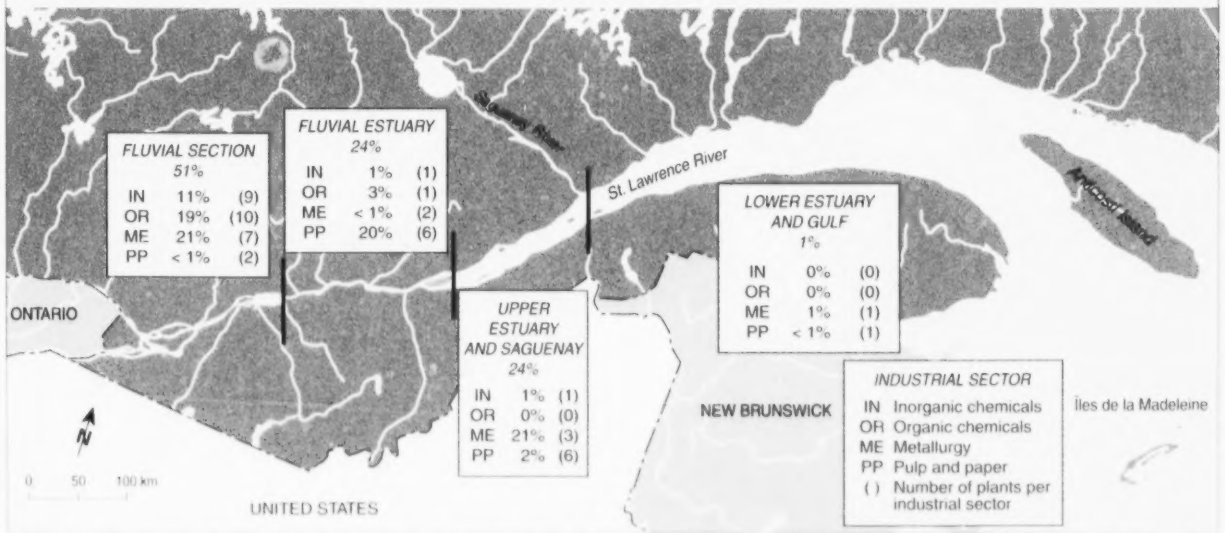

Source:
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The St. Lawrence River – Tributary Inputs of Inorganic Toxics (1991)

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The greater the Chimiotox Index, the higher the toxic discharge.

$$CU_A = Load_A \times F_{tox\ A}$$

$$CI_{tributary} = CU = CU_A + CU_B + \ldots CU_Z$$

where

CU_A: Chimiotox Unit of pollutant A at the mouth of the tributary;

$Load_A$: Quantity of pollutant A discharged into the St. Lawrence in a single day by the given source, in kilograms per day;

$F_{tox\ A}$: Toxic weighting factor of pollutant A;

$CI_{tributary}$: Chimiotox Index of pollutants A to Z measured at the mouth of the tributary.

The Chimiotox Index was used to assess inputs of nine metals at the mouths of several tributaries of the St. Lawrence River.

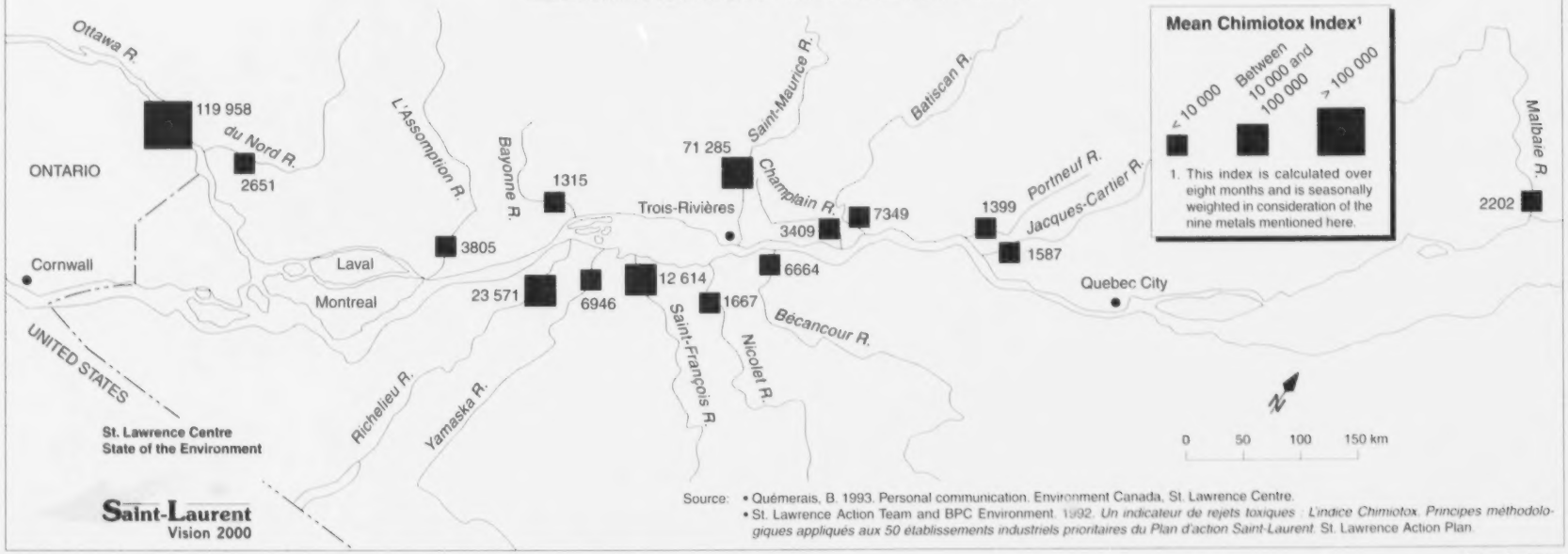
CLASSIFICATION OF TRIBUTARIES BY SEASONAL CHIMIOTOX INDEX FOR 9 METALS*

Summer 1991		Autumn 1991	
• Saint-Maurice	72 032	• Ottawa	250 640
• Ottawa	41 551	• Saint-Maurice	70 037
• Richelieu	31 553	• Saint-François	25 230
• Yamaska	7 179	• Bécancour	16 271
• Saint-François	5 044	• Batiscan	15 600
• L'Assomption	3 806	• Richelieu	10 271
• Champlain	3 530	• Yamaska	6 555
• Malbaie	3 053	• du Nord	5 198
• Batiscan	2 400	• Champlain	3 210
• Nicolet	1 879	• Portneuf	2 719
• Jacques-Cartier	1 464	• Sainte-Anne	2 012
• du Nord	1 122	• Maskinongé	1 941
• Bécancour	900	• St. Regis (Cornwall)	1 838
• Chaudière	811	• Jacques-Cartier	1 792
• du Loup (Louiseville)	811	• Châteauguay	1 764

* The seasonal Chimiotox Index is the sum of each season's Chimiotox units for cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc.

Note: The table and map show only the 15 tributaries with the greatest inorganic toxic inputs (highest Chimiotox indexes).

MEAN CHIMIOTOX INDEX OF TRIBUTARIES FOR 9 METALS



Source:
- Quémerais, B. 1993. Personal communication. Environment Canada, St. Lawrence Centre.
- St. Lawrence Action Team and BPC Environment. 1992. *Un indicateur de rejets toxiques : L'indice Chimiotox. Principes méthodologiques appliqués aux 50 établissements industriels prioritaires du Plan d'action Saint-Laurent.* St. Lawrence Action Plan.

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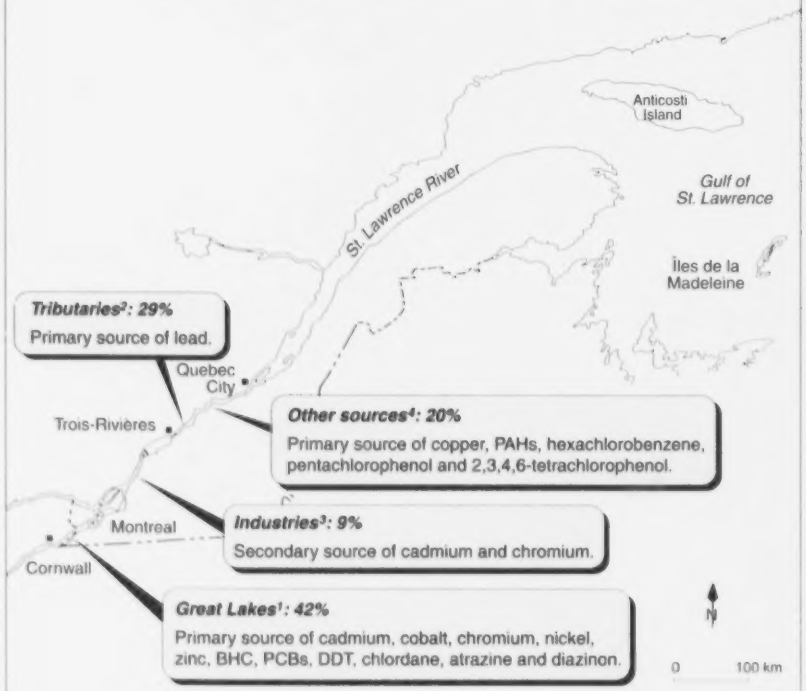
The St. Lawrence River – Relative Importance of the Main Sources of Contamination

MEASURING TOXIC INPUTS IN THE RIVER

THE MEAN RELATIVE CONTRIBUTION of the main contaminant sources of the St. Lawrence River (Great Lakes, tributaries and industries) is assessed based on the toxic loads contributed by these sources to the St. Lawrence. The summary results in the adjacent table and on the map below give the reader a rough idea of the main contaminant sources measured at Quebec City. A word of caution: toxic effects do not figure in the calculated percentages, and sampling and analysis variations may be greater, in some cases.

MAIN CONTAMINANTS AND ASSOCIATED SOURCES



RELATIVE IMPORTANCE OF MAIN CONTAMINANT SOURCES IN RELATION TO TOTAL LOAD MEASURED AT QUEBEC CITY IN 1991

CONTAMINANTS	SOURCES (%) Great Lakes[1]	Tributaries[2]	Industries[3]	Other sources[4]	TOTAL
Inorganics					
• Cadmium	39	31	28	2	100
• Cobalt	38	26	1	35	100
• Chromium	54	24	22	0	100
• Copper	25	24	5	46	100
• Nickel	63	21	8	8	100
• Lead	32	52	2	14	100
• Zinc	58	44	34	-36	100
Mean contribution	**44**	**32**	**14**	**10**	**100**
Organics					
• BHC	54	45	0	1	100
• PCBs	34	14	22	30	100
• DDT	57	42	0	1	100
• PAHs	27	22	3	48	100
• Chlordane	71	26	0	3	100
• Atrazine	58	10	0	32	100
• Diazinon	39	31	0	30	100
• Hexachlorobenzene	9	9	–	82	100
• Pentachlorophenol	26	27	1	46	100
• 2,3,4,6-tetrachlorophenol	25	31	0	44	100
Mean contribution	**40**	**26**	**3**	**31**	**100**
TOTAL CONTRIBUTION	42	29	9	20	100

– : No data.

1. Input of Great Lakes and international section of the St. Lawrence, measured at Cornwall.
2. Input of 50-odd tributaries between Cornwall and Quebec City, sampled at their mouths.
3. Effluent discharged by 24 Action Plan priority plants located between Cornwall and Quebec City, and emptied directly into the St. Lawrence. The data used to assess industrial contribution were gathered prior to the introduction of reduction measures under the Action Plan.
4. Atmospheric deposition, municipal effluents discharged directly to the St. Lawrence, resuspension of sediments, contaminant release by biota, etc. These inputs were calculated as shown below. A negative result indicates that the contaminants are not retained during transport (due to biodegradation, volatilization or sedimentation of contaminant-bearing particles).

$$\text{Other sources: } \frac{\text{Load measured at Quebec City} - (\text{load of Great Lakes} + \text{tributaries} + \text{industries})}{\text{Load measured at Quebec City}} \times 100$$

Source: Lemieux, C., T. T. Pham, and B. Quémerais. 1993. *Identification des sources de pollution le long du Saint-Laurent et leur importance relative*. 61st ACFAS Conference.

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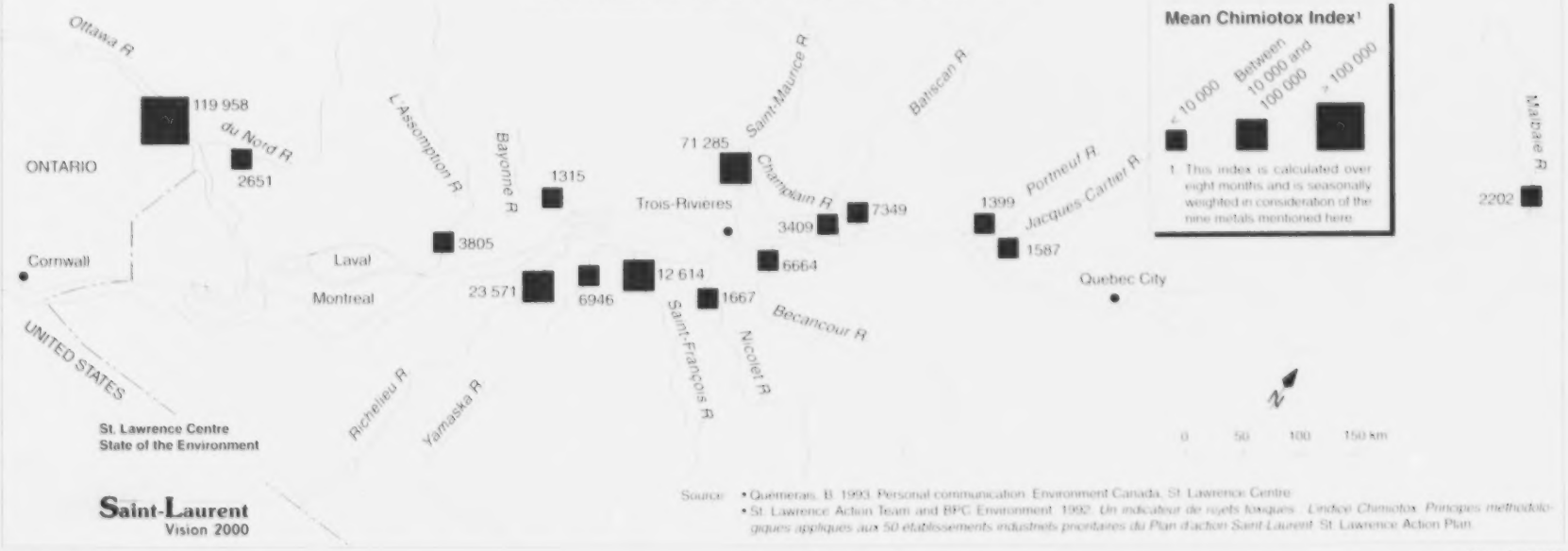
• Saint-François	5 044	• Batiscan	15 600
• L'Assomption	3 806	• Richelieu	10 271
• Champlain	3 530	• Yamaska	6 555
• Malbaie	3 053	• du Nord	5 198
• Batiscan	2 400	• Champlain	3 210
• Nicolet	1 879	• Portneuf	2 719
• Jacques-Cartier	1 464	• Sainte-Anne	2 012
• du Nord	1 122	• Maskinongé	1 941
• Bécancour	900	• St. Regis (Cornwall)	1 838
• Chaudière	811	• Jacques-Cartier	1 792
• du Loup (Louiseville)	811	• Châteauguay	1 764

* The seasonal Chimiotox Index is the sum of each season's Chimiotox units for cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc.

Note: The table and map show only the 15 tributaries with the greatest inorganic toxic inputs (highest Chimiotox indexes).

MEAN CHIMIOTOX INDEX OF TRIBUTARIES FOR 9 METALS



Source: • Quémerais, B. 1993. Personal communication. Environment Canada, St. Lawrence Centre.
• St. Lawrence Action Team and BPC Environment. 1992. *Un indicateur de rejets toxiques : l'indice Chimiotox. Principes méthodologiques appliqués aux 50 établissements industriels prioritaires du Plan d'action Saint-Laurent*. St. Lawrence Action Plan.

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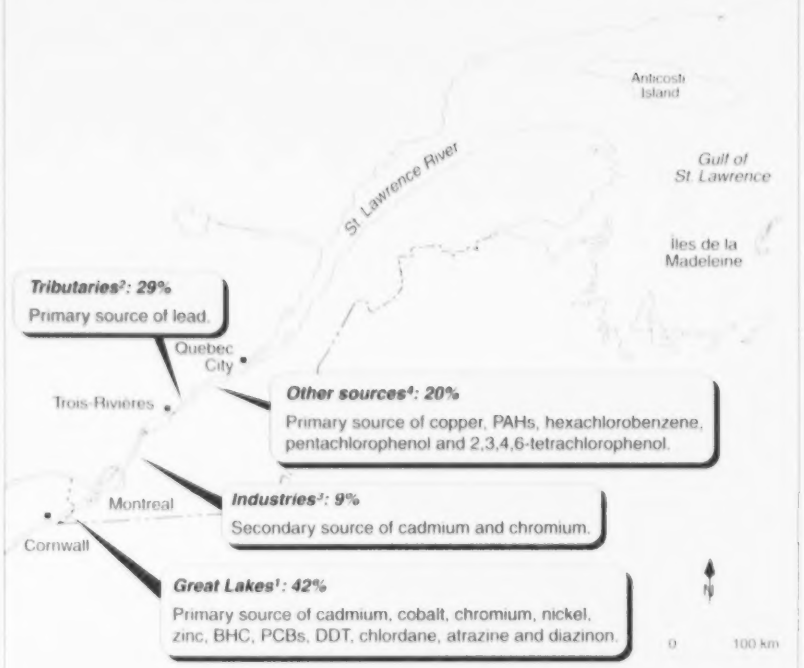
The St. Lawrence River – Relative Importance of the Main Sources of Contamination

MEASURING TOXIC INPUTS IN THE RIVER

THE MEAN RELATIVE CONTRIBUTION of the main contaminant sources of the St. Lawrence River (Great Lakes, tributaries and industries) is assessed based on the toxic loads contributed by these sources to the St. Lawrence. The summary results in the adjacent table and on the map below give the reader a rough idea of the main contaminant sources measured at Quebec City. A word of caution: toxic effects do not figure in the calculated percentages, and sampling and analysis variations may be greater, in some cases.

MAIN CONTAMINANTS AND ASSOCIATED SOURCES



RELATIVE IMPORTANCE OF MAIN CONTAMINANT SOURCES IN RELATION TO TOTAL LOAD MEASURED AT QUEBEC CITY IN 1991

	SOURCES (%)				
CONTAMINANTS	Great Lakes[1]	Tributaries[2]	Industries[3]	Other sources[4]	TOTAL
Inorganics					
• Cadmium	39	31	28	2	100
• Cobalt	38	26	1	35	100
• Chromium	54	24	22	0	100
• Copper	25	24	5	46	100
• Nickel	63	21	8	8	100
• Lead	32	52	2	14	100
• Zinc	58	44	34	-36	100
Mean contribution	**44**	**32**	**14**	**10**	**100**
Organics					
• BHC	54	45	0	1	100
• PCBs	34	14	22	30	100
• DDT	57	42	0	1	100
• PAHs	27	22	3	48	100
• Chlordane	71	26	0	3	100
• Atrazine	58	10	0	32	100
• Diazinon	39	31	0	30	100
• Hexachlorobenzene	9	9	–	82	100
• Pentachlorophenol	26	27	1	46	100
• 2,3,4,6-tetrachlorophenol	25	31	0	44	100
Mean contribution	**40**	**26**	**3**	**31**	**100**
TOTAL CONTRIBUTION	**42**	**29**	**9**	**20**	**100**

– : No data

1. Input of Great Lakes and international section of the St. Lawrence, measured at Cornwall.
2. Input of 50-odd tributaries between Cornwall and Quebec City, sampled at their mouths.
3. Effluent discharged by 24 Action Plan priority plants located between Cornwall and Quebec City, and emptied directly into the St. Lawrence. The data used to assess industrial contribution were gathered prior to the introduction of reduction measures under the Action Plan.
4. Atmospheric deposition, municipal effluents discharged directly to the St. Lawrence, resuspension of sediments, contaminant release by biota, etc. These inputs were calculated as shown below. A negative result indicates that the contaminants are not retained during transport (due to biodegradation, volatilization or sedimentation of contaminant-bearing particles).

$$\text{Other sources} = \frac{\text{Load measured at Quebec City} - (\text{load of Great Lakes + tributaries + industries})}{\text{Load measured at Quebec City}} \times 100$$

Source: Lemieux, C., T. T. Pham, and B. Quémerais. 1993. *Identification des sources de pollution le long du Saint Laurent et leur importance relative*. 61st ACFAS Conference.

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INFO-FLASH 78

The St. Lawrence River – Water Quality: Primary-Contact Recreation

PHYSICO-CHEMICAL AND BACTERIOLOGICAL WATER QUALITY

THE NOTION OF WHAT CONSTITUTES GOOD WATER QUALITY varies according to its use. Two indexes have been developed by the St. Lawrence Centre to assess water quality for primary-contact recreational activities (swimming and windsurfing). These indexes take two complementary aspects—the water's physico-chemical and bacteriological quality—into account. By examining a number of parameters, a more accurate profile of the water quality results. An overall assessment of St. Lawrence water quality can be used to compare its various water masses for a given use. The water sampling data used to prepare these indexes were taken from federal and provincial monitoring networks.

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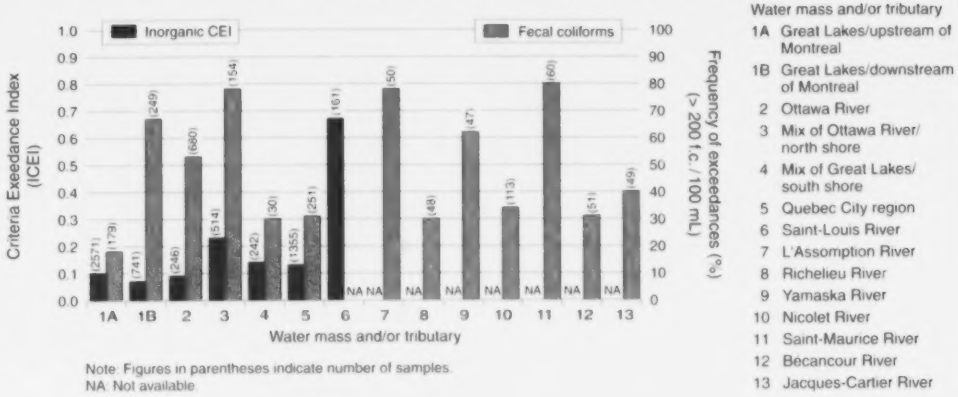
Water quality criteria of parameters selected to calculate the ICEI: Primary-contact recreation

Parameter	Criterion	Parameter	Criterion
Turbidity	10.00 NTU	Copper	1.00 mg/L
Phosphorus	0.03 mg/L	Manganese	0.50 mg/L
Barium	1.00 mg/L	Nickel	0.25 mg/L
Cadmium	0.01 mg/L	Lead	0.05 mg/L
Chromium	0.05 mg/L	Zinc	5.00 mg/L

Note: The same criteria have been adopted by the Ministère de l'Environnement et de la Faune for most parameters.

CRITERIA EXCEEDANCE INDEX FOR INORGANIC SUBSTANCES (ICEI) AND FREQUENCY OF CRITERIA EXCEEDANCES FOR FECAL COLIFORMS



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Water mass and/or tributary

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11 Saint-Maurice River
12 Becancour River
13 Jacques-Cartier River

WATER QUALITY FOR RECREATIONAL ACTIVITIES: AN OVERVIEW

Physico-Chemical Quality

Concentrations of inorganic substances do not hinder the practice of recreational activities involving contact with water because no criteria exceedances were reported for the eight metals examined. Phosphorus and turbidity are the parameters with the greatest impacts on the quality of water for this type of use. Although they pose no risk to human health, they may, for aesthetic reasons, restrict recreational activities with water contact.

Exceedances of the criteria for inorganic substances (ICEI) are low, with values between 0.07 and 0.67. The highest ICEI values are found in the water masses of the Saint-Louis River (0.67) and the Ottawa River/ north shore tributary mix. (0.23). The Great Lakes water mass upstream of Montreal and that of the Ottawa River present the lowest ICEI values (0.07 and 0.09, respectively). Between Cornwall and Quebec City, total phosphorus concentrations go from 0.01 mg/L to 0.04 mg/L. Turbidity levels in the St. Lawrence are low upstream of Montreal. Downstream, turbidity increases on both the north and south shore, especially in the Lake Saint-Pierre region.

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The bacterial quality of the entire St. Lawrence is poor. The most problematic areas are located between the Island of Montreal and Quebec City.

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The St. Lawrence River – Water Quality: Direct Human Consumption

PHYSICO-CHEMICAL WATER QUALITY

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Water quality criteria of parameters selected to calculate the ICEI: Direct human consumption

Parameter	Criterion	Parameter	Criterion
Sodium	200.0 mg/L	Cadmium	0.005 mg/L
Chlorides	250.0 mg/L	Copper	1.0 mg/L
Sulphates	500.0 mg/L	Zinc	5.0 mg/L
Turbidity	5.0 UTN	Lead	0.01 mg/L
Manganese	0.05 mg/L	Barium	1.0 mg/L
Iron	0.3 mg/L	Chromium	0.05 mg/L

Note: The criteria for most parameters are the same as those recommended by Health Canada.

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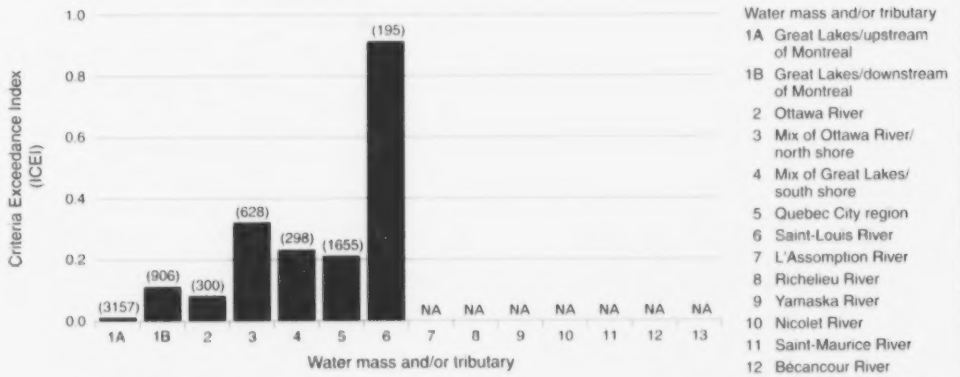

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NA: Not available.

PHYSICO-CHEMICAL WATER QUALITY FOR DIRECT HUMAN CONSUMPTION: AN OVERVIEW

Concentrations of inorganic substances detected in the fresh water of the St. Lawrence River do not restrict direct, pretreatment human consumption.

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The St. Lawrence River – Water Quality: Primary-Contact Recreation

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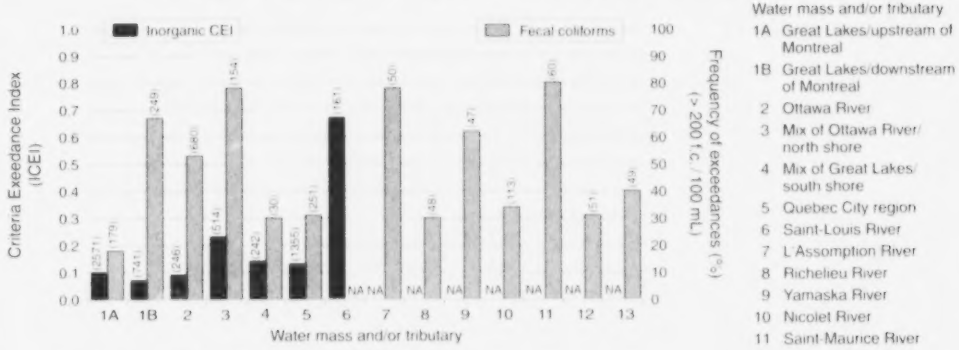

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The St. Lawrence River – Water Quality: Direct Human Consumption

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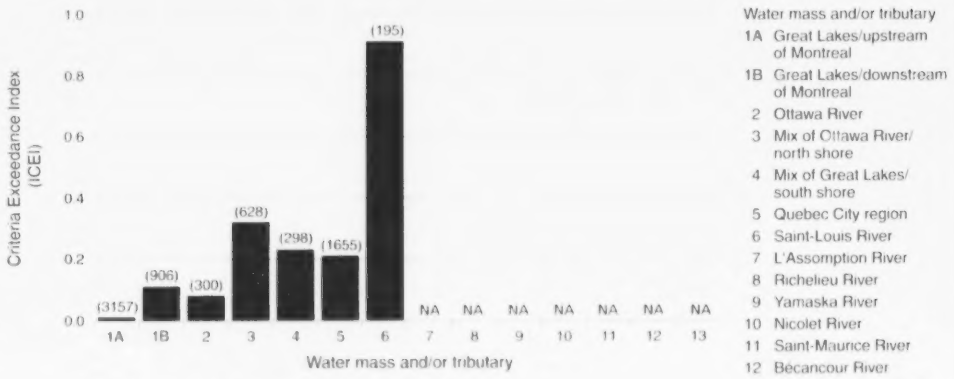

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INFO-FLASH 79b

The St. Lawrence River – Water Quality: Direct Human Consumption

BACTERIOLOGICAL WATER QUALITY

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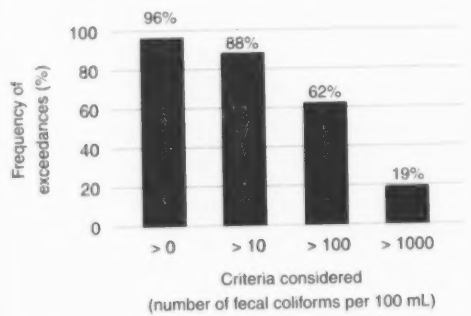
Index of bacteriological water quality

Fecal coliforms are associated with the waste products of warm-blooded vertebrates. As such, these bacteria serve as indicators of the bacterial contamination of water intended for direct human consumption. The types of fecal coliforms most often encountered in the aquatic environment are *Eschericia*, *Enterobacter* and *Klebsiella*. *Eschericia coli* alone represents 75–95% of the fecal coliforms detected in water. The more fecal coliforms, the greater the probability of finding certain pathogenic elements (viruses or bacteria) in water, with direct effects on human health.

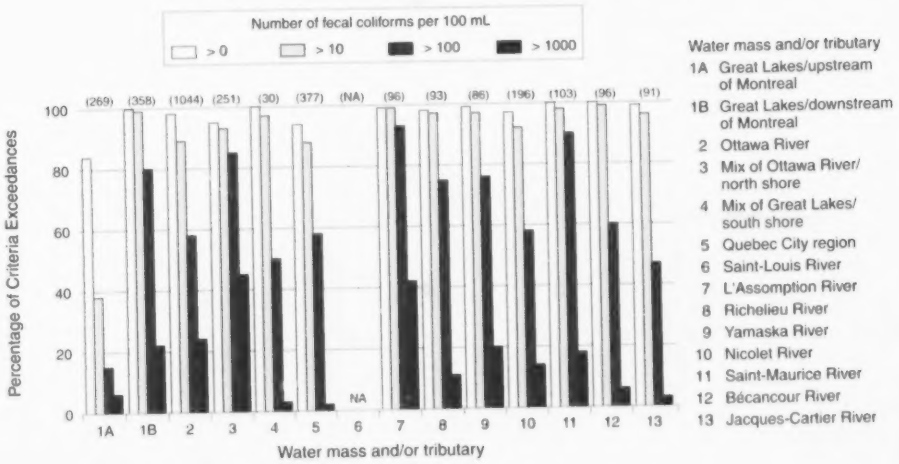
The selected index is based on the percentage of exceedances of four levels of bacterial contamination. **Drinking water should contain no fecal coliforms whatsoever.** The other levels (> 10, > 100 and > 1000 f.c./100 mL) provide indications about the degree of treatment necessary to render the water potable. The type of treatment required by contaminated water depends in part on the average number of coliform bacteria found over a period of 30 consecutive days.

Frequency of exceedances of fecal coliform criteria throughout the St. Lawrence, between Cornwall and Montmagny



Note: 3090 samples were drawn between 1990 and 1993

FREQUENCY OF EXCEEDANCES OF FECAL COLIFORM CRITERIA IN THE WATER MASSES BETWEEN CORNWALL AND MONTMAGNY (1990–93)



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BACTERIOLOGICAL WATER QUALITY FOR DIRECT HUMAN CONSUMPTION: AN OVERVIEW

Water from the St. Lawrence cannot be consumed directly (without treatment) because of its poor bacteriological quality.

The bacteriological quality of the St. Lawrence River is generally bad. Fecal coliforms have been detected in almost all water samples analysed. More than 84% of samples drawn from each St. Lawrence water mass contain fecal coliforms, thereby exceeding the criterion for human consumption (0 f.c./100 mL). The most problematic areas are situated in water masses where the frequency of criteria exceedances is greater than 99%: in the water mass of the Great Lakes/downstream of Montreal, Great Lakes/south shore tributary mix, and the Saint-Maurice and Bécancour rivers. Very high bacterial counts (more than 1000 f.c./100 mL) are more frequent in the water mass of the Ottawa River/north shore tributary mix, along with that of the L'Assomption River, where 45% and 42%, respectively, of samples exceeded the criterion.

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INFO-FLASH 80a

The St. Lawrence River – Water Quality: Aquatic Life

PHYSICO-CHEMICAL WATER QUALITY

THE NOTION OF WHAT CONSTITUTES GOOD WATER QUALITY varies according to its use. Two indexes have been developed by the St. Lawrence Centre to assess physico-chemical water quality in terms of its capacity to receive and sustain aquatic life. Criteria relative to aquatic life (chronic toxicity) apply to concentrations of substances to which aquatic organisms and their offspring can be exposed indefinitely with no adverse effects. This index takes two types of parameters into account: inorganic (ICEI) and organic (OCEI); the latter is the subject of Info-Flash fact sheet 80b. By examining a number of parameters, a more accurate profile of the water quality results. An overall assessment of St. Lawrence water quality can be used to compare its various water masses for a given use. The water sampling data used to prepare these indexes were taken from federal and provincial monitoring networks.

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$$CEI = [\Sigma(A_i \times F_i)]/n$$

CEI: Value of Criteria Exceedance Index

A_i: Mean amplitude of criteria exceedance for parameter *i*

F_i: Frequency of criteria exceedance (as a percentage) of parameter *i*

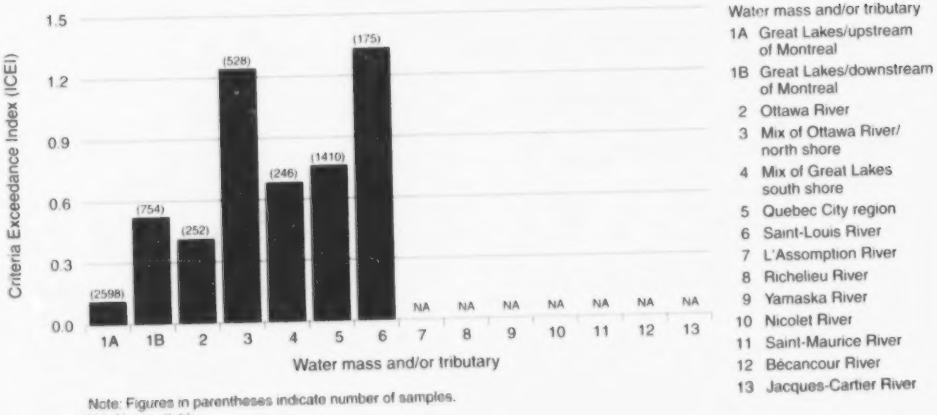
n: Number of parameters.

Water quality criteria of parameters selected to calculate the ICEI: Aquatic life

Parameter	Criteria (mg/L) Hardness: 120	Hardness: 30
Aluminum	0.087	0.087
Barium	50.00	50.00
Cadmium	0.0013	0.00044
Chromium	0.002	0.002
Cobalt	0.005	0.005
Copper	0.00276	0.002
Iron	0.30	0.30
Molybdenum	1.00	1.00
Nickel	0.1840	0.0569
Lead	0.004	0.00069
Vanadium	0.014	0.014
Zinc	0.1237	0.0382

Note: The same criteria have been adopted by the Ministère de l'Environnement et de la Faune for most parameters.

CRITERIA EXCEEDANCE INDEX FOR INORGANIC SUBSTANCES (ICEI) IN THE WATER MASSES BETWEEN CORNWALL AND MONTMAGNY (1985–1990)



Note: Figures in parentheses indicate number of samples.
NA: Not available.

PHYSICO-CHEMICAL WATER QUALITY FOR AQUATIC LIFE: AN OVERVIEW OF INORGANIC SUBSTANCES

Exceedances of the criteria for inorganic substances (ICEI) are relatively low in the freshwater St. Lawrence, with values ranging between 0.11 and 1.33. There are a number of areas where the water quality has been degraded. The Saint-Louis River water mass has the highest ICEI value (1.33). The next highest is found downstream of Montreal, in the Ottawa River/north shore tributary mix (ICEI: 1.24); it is characterized by a high frequency of criteria exceedances for copper and lead. The Quebec City region follows with an ICEI of 0.76. Another area, located near Sorel, affects the Great Lakes/south shore tributary mix (ICEI: 0.68). Industrial discharges in this region cause criteria exceedances for copper and chromium. The Great Lakes water mass upstream of Montreal has the fewest discrepancies relative to the criteria for inorganic substances (ICEI: 0.11).

Five inorganic substances are responsible for the ICEI variances. Chromium, copper and lead are potentially harmful to aquatic life. Nonetheless, it is important to stress that the criteria for some metals change as a function of water hardness, which may influence metal bioavailability. As such, the toxic risks of copper and lead are greater in the brown waters on the north shore of the St. Lawrence, where the water is less hard. Iron and aluminum are both strongly associated with suspended solids and therefore pose no risk of chronic toxicity at pH levels observed in the St. Lawrence.

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The St. Lawrence River – Water Quality: Direct Human Consumption

BACTERIOLOGICAL WATER QUALITY

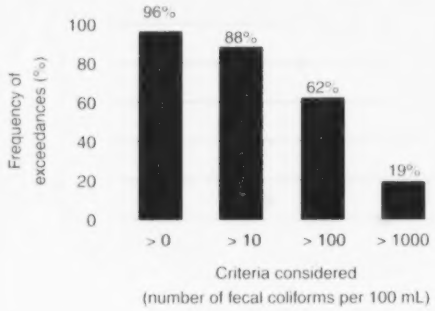
THE NOTION OF WHAT CONSTITUTES GOOD WATER QUALITY varies according to its use. Two indexes have been developed by the St. Lawrence Centre to assess water quality for direct human consumption (that is, water that is not treated before drinking). These indexes take two complementary aspects—bacteriological and physico-chemical water quality—into account; the latter is the subject of Info-Flash fact sheet 79a. By examining a number of parameters, a more accurate profile of the water quality results. An overall assessment of St. Lawrence water quality can be used to compare its various water masses for a given use. The water sampling data used to prepare these indexes were taken from federal and provincial monitoring networks.

Index of bacteriological water quality

Fecal coliforms are associated with the waste products of warm-blooded vertebrates. As such, these bacteria serve as indicators of the bacterial contamination of water intended for direct human consumption. The types of fecal coliforms most often encountered in the aquatic environment are *Eschericia*, *Enterobacter* and *Klebsiella*. *Eschericia coli* alone represents 75–95% of the fecal coliforms detected in water. The more fecal coliforms, the greater the probability of finding certain pathogenic elements (viruses or bacteria) in water, with direct effects on human health.

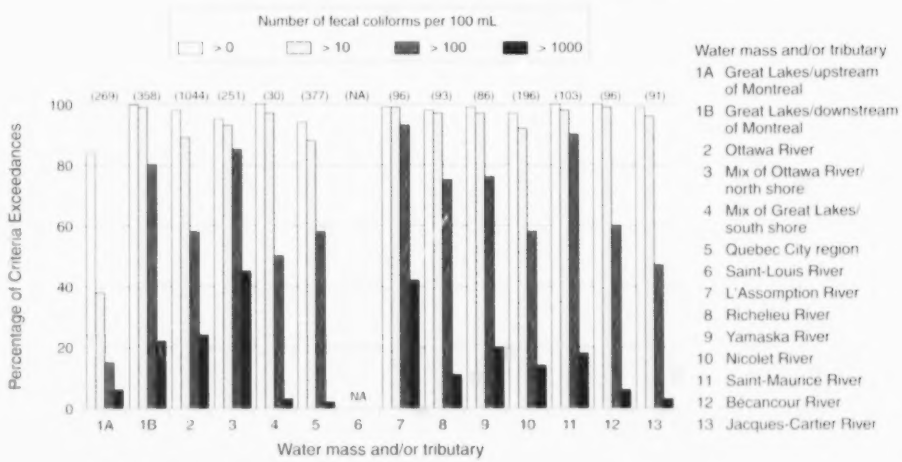
The selected index is based on the percentage of exceedances of four levels of bacterial contamination. **Drinking water should contain no fecal coliforms whatsoever.** The other levels (> 10, > 100 and > 1000 f.c./100 mL) provide indications about the degree of treatment necessary to render the water potable. The type of treatment required by contaminated water depends in part on the average number of coliform bacteria found over a period of 30 consecutive days.

Frequency of exceedances of fecal coliform criteria throughout the St. Lawrence, between Cornwall and Montmagny



Note: 3090 samples were drawn between 1990 and 1993

FREQUENCY OF EXCEEDANCES OF FECAL COLIFORM CRITERIA IN THE WATER MASSES BETWEEN CORNWALL AND MONTMAGNY (1990–93)



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The St. Lawrence River – Water Quality: Aquatic Life

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Water quality criteria of parameters selected to calculate the ICEI: Aquatic life

	Criteria (mg/L)	
Parameter	**Hardness: 120**	**Hardness: 30**
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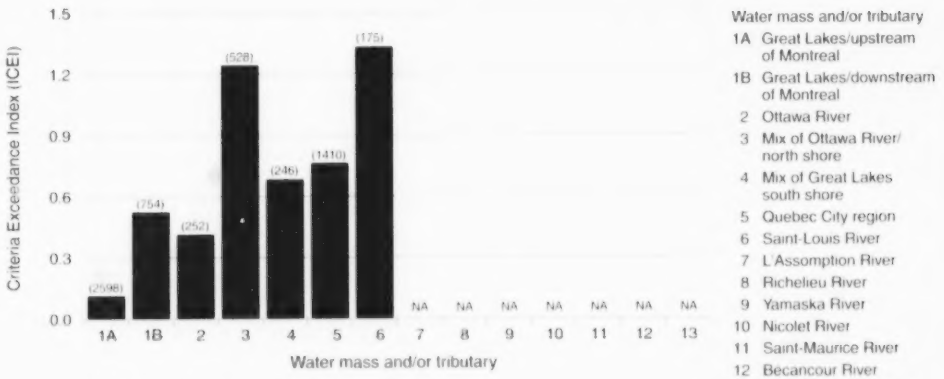

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The St. Lawrence River – Water Quality: Aquatic Life

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Water quality criteria of parameters selected to calculate the OCEI: Aquatic life

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Acenaphthene	3 000
Naphthalene	29 000
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PCBs	1

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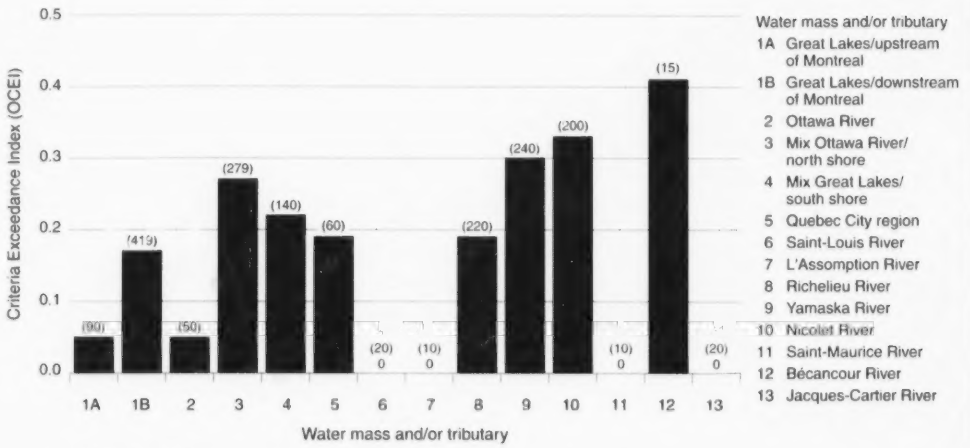

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PHYSICO-CHEMICAL WATER QUALITY FOR AQUATIC LIFE: AN OVERVIEW OF ORGANIC SUBSTANCES

Exceedances of criteria relative to organic substances are relatively low in the freshwater St. Lawrence, with OCEI values ranging between 0.00 and 0.41. The OCEI is very low upstream of Montreal, and increases variously in the water masses downstream of Montreal. The Bécancour River water mass has the highest OCEI (0.41), followed by the water mass of the Nicolet River (0.33), that of the Yamaska River (0.30), and then the Ottawa River/north shore tributary mix (0.27). No criteria exceedances for organic substances (OCEI: 0) were detected in the water masses of the Saint-Louis, L'Assomption, Saint-Maurice and Jacques-Cartier rivers. The substances responsible for these trends are PCBs and DDT and its derivatives.

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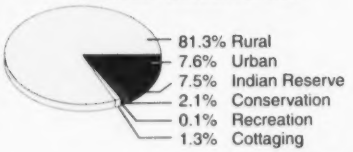
INFO-FLASH 81

The St. Lawrence River – Priority Intervention Zone: Lake Saint-François

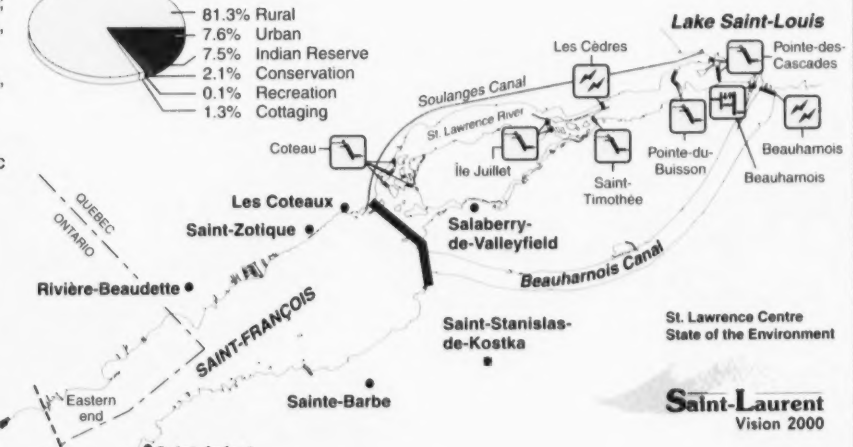
HUMAN PRESENCE

- The population is split among 11 municipalities and the Akwesasne Indian Reserve.
- Main urban and industrial centres are located at the limits of Lake Saint-François (Cornwall–Massena and Salaberry-de-Valleyfield).
- Cottages cover 47% of the lakeshore.
- Intensive farming activities are focused on grain crops.
- Domestic wastewater is discharged, for the most part, to septic tanks.
- Main species of fish caught by commercial fishers: American eel and Brown bullhead; by sport fishers: Yellow perch, Walleye, Northern pike, and Smallmouth bass.
- More than 30 000 ducks, mostly dabblers, taken during the hunting season.
- Popularity of nature-watching activities.
- Number of monitored beaches: 3 in Quebec and 4 in Ontario.

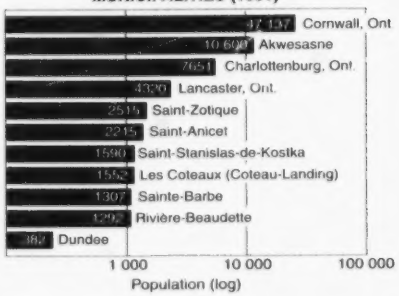
DESIGNATED LAND USE IN RIVERSIDE MUNICIPALITIES

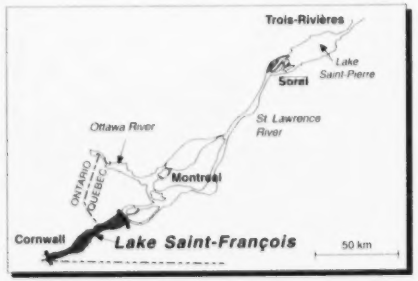


ZIP 1 and 2 – LAKE SAINT-FRANÇOIS



POPULATION OF RIVERSIDE MUNICIPALITIES (1991)





Note: Priority Intervention Zones are better known by their French acronym, ZIP.

MAIN ENVIRONMENTAL PROBLEMS

- Dams and regulating structures upstream and downstream limit the movement of migratory fish: American eel and Lake sturgeon.
- Toxic substances in the ecosystem: in the sediment, and in animal and plant life.
- Introduction of exotic species: Zebra mussel, Quagga mussel.
- Restrictions on use: consumption of fish and waterfowl from the lake.
- Shoreline development: encroachment on the riparian environment and wetlands, reduced accessibility to the lakeshore due to privatization.

PHYSICO-CHEMICAL ASPECTS

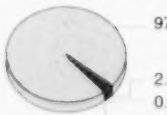
- First natural widening of the St. Lawrence River.
- Chemical and bacteriological water quality generally good.
- A 190-km-long shoreline, excluding islands; 81 km lie within Quebec's borders.
- Ever since construction of the Beauharnois hydro-electric generating station in 1930, Lake Saint-François has functioned as a reservoir: the water level was raised by 40 cm and does not fluctuate with the seasons.

A DIVERSIFIED ENVIRONMENT

- Numerous islands and wide expanses of wetlands in the western end of the lake.
- Diverse wildlife: 57 fish species, 28 amphibians and reptiles, 260 bird species and 47 different mammals.
- Important staging area and major flyway for waterfowl.
- Several rare, threatened or at-risk plant and animal species.
- Protected lands: Lake Saint-François National Wildlife Area and Cooper Marsh.

WETLANDS – WESTERN END

WETLANDS – EASTERN END



Source: Technical reports and regional assessment report on Lake Saint-François sector, 1994. Environment Canada – Quebec Region, Environmental Conservation, St. Lawrence Centre. Reports on Priority Intervention Zones (ZIP) 1 and 2.

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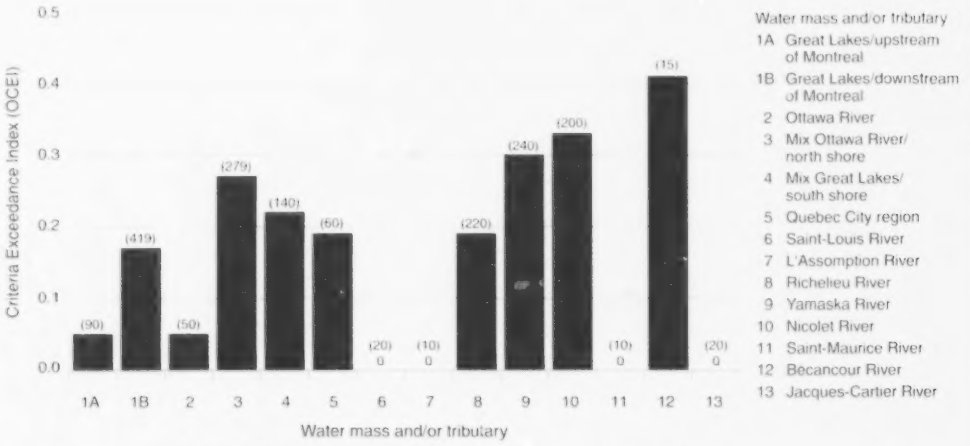

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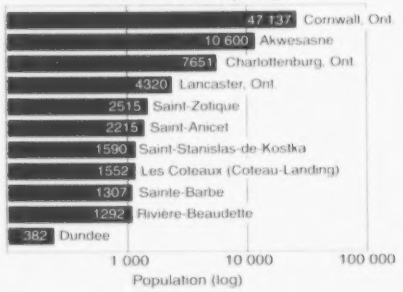
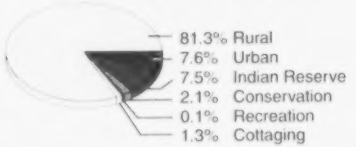
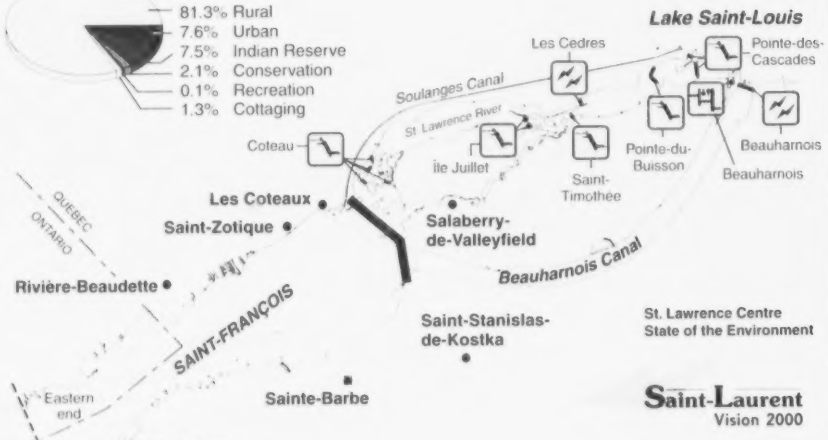


DESIGNATED LAND USE IN RIVERSIDE MUNICIPALITIES



ZIP 1 and 2 – LAKE SAINT-FRANÇOIS



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Note: Priority Intervention Zones are better known by their French acronym, ZIP.

MAIN ENVIRONMENTAL PROBLEMS

- Dams and regulating structures upstream and downstream limit the movement of migratory fish: American eel and Lake sturgeon.
- Toxic substances in the ecosystem: in the sediment, and in animal and plant life.
- Introduction of exotic species: Zebra mussel, Quagga mussel.
- Restrictions on use: consumption of fish and waterfowl from the lake.
- Shoreline development: encroachment on the riparian environment and wetlands, reduced accessibility to the lakeshore due to privatization.

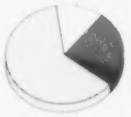
PHYSICO-CHEMICAL ASPECTS

- First natural widening of the St. Lawrence River.
- Chemical and bacteriological water quality generally good.
- A 190-km-long shoreline, excluding islands; 81 km lie within Quebec's borders.
- Ever since construction of the Beauharnois hydro-electric generating station in 1930, Lake Saint-François has functioned as a reservoir: the water level was raised by 40 cm and does not fluctuate with the seasons.

A DIVERSIFIED ENVIRONMENT

- Numerous islands and wide expanses of wetlands in the western end of the lake.
- Diverse wildlife: 57 fish species, 28 amphibians and reptiles, 260 bird species and 47 different mammals.
- Important staging area and major flyway for waterfowl.
- Several rare, threatened or at-risk plant and animal species.
- Protected lands: Lake Saint-François National Wildlife Area and Cooper Marsh.

WETLANDS – WESTERN END



13.0% Swamp
19.7% Wet meadow
5.1% Marsh
62.2% Aquatic plant community

WETLANDS – EASTERN END

97.3% Aquatic plant community
2.0% Swamp
0.6% Wet meadow
0.1% Marsh

Source: Technical reports and regional assessment report on Lake Saint-François sector. 1994. Environment Canada – Quebec Region, Environmental Conservation, St. Lawrence Centre. Reports on Priority Intervention Zones (ZIP) 1 and 2.

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March 1997

The St. Lawrence River – Priority Intervention Zone: Montreal–Longueuil

St. Lawrence Centre
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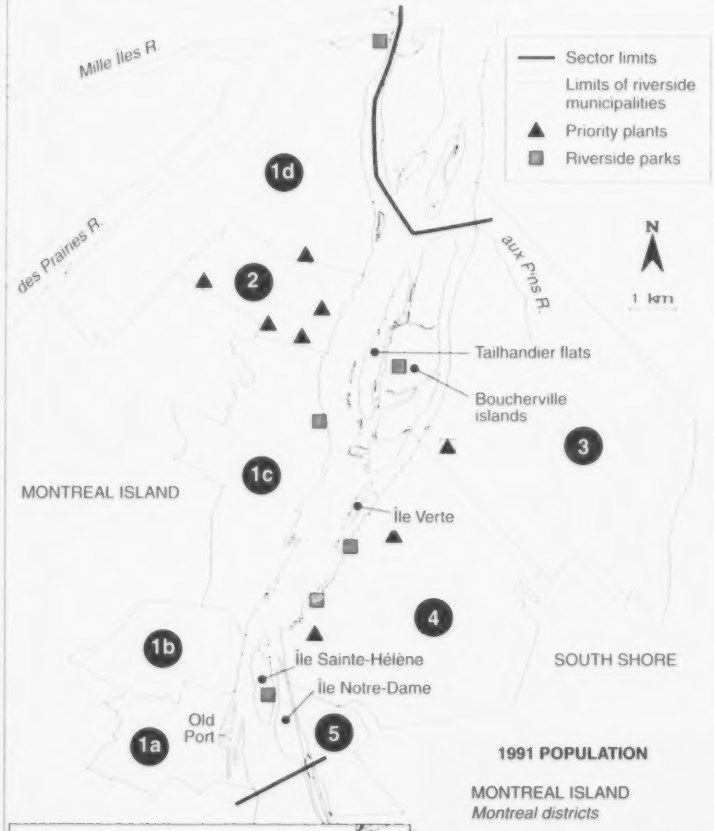
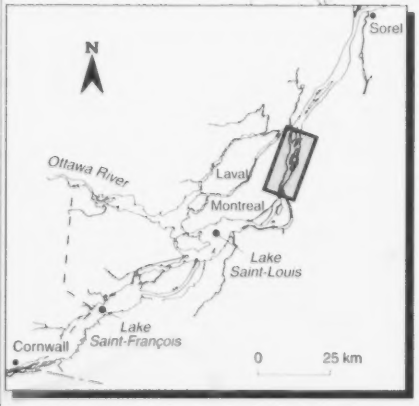
Saint-Laurent
Vision 2000

ZIP 9 – MONTREAL–LONGUEUIL





1991 POPULATION

MONTREAL ISLAND
Montreal districts

		Residents
1a	Ville-Marie	51 395
1b	Plateau Mont-Royal–Centre-Sud	118 652
1c	Mercier–Hochelaga-Maisonneuve	134 595
1d	Pointe-aux-Trembles–Rivières-des-Prairies	94 602
2	Montréal-Est	3 767
	SOUTH SHORE	
3	Boucherville	33 796
4	Longueuil	129 874
5	Saint-Lambert	20 976

Here, the River...

♦ is 21 km long and an average 4 km wide; ♦ composed of water from the Great Lakes and the Ottawa River; ♦ has a mean annual discharge of 9182 m^3/s; ♦ a flow velocity that reaches 3 m/s on the north shore; ♦ and crosses a 231-km^2, multi-vocational region.

A Natural Beauty...

♦ rich in diversified habitats; ♦ with 945 ha of wetlands; ♦ spawning grounds with great potential (like the channels of the Boucherville islands, aux Pins River); ♦ waterfowl brood-rearing areas (like the Tailhandier flats, Île Saint-Jean, Île Verte); ♦ and the Boucherville archipelago, a unique natural haven for at least 250 species of vascular plants, and 15 of the 16 mammal, 38 of the 58 fish, and 170 of the 250 bird species found throughout the Montreal–Longueuil sector.

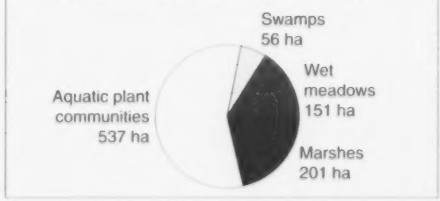
An Urban River...

♦ bordered by five riverside municipalities (including four riverside districts of Montreal); ♦ with 588 000 residents in 1991; ♦ land that is given over primarily to urban and industrial use (72%); ♦ where farming is in decline (average dezoning rate of 22%); ♦ and eight priority industrial plants of the St. Lawrence Vision 2000 action plan can be found; ♦ along with 26 hazardous waste sites, particularly on the north shore; ♦ and a road infrastructure bordering on the River.

The Human Presence

♦ The St. Lawrence supplies drinking water to 99% of sector residents; ♦ it acts as a discharge site for municipal wastewater and industrial effluent; ♦ figures in commercial activities of the Port of Montreal: 19.5 million tonnes of goods handled in 1994; ♦ linked to 11 500 direct and indirect jobs in Quebec in 1990, and economic spinoffs of $1.25 billion for the whole country; ♦ offers a range of recreational activities (like sport fishing: 64 000 fisher-days in the area and in the La Prairie basins); along with river cruises and shuttles; eight marinas, waterfowl hunting (esp. dabbling ducks), and nature watching on the islands.

DISTRIBUTION OF WETLANDS IN 1990



The Legacy of an Urban Lifestyle

♦ Water: problematic pollutants (phosphorus and fecal coliforms); ♦ riverbed: contaminated sediment in the port area; ♦ encroachment on natural habitats; ♦ use compromised: swimming, fish consumption (mercury criterion exceeded); ♦ loss of habitats: 1600 ha since 1945, of which 500 ha were wetlands; ♦ several species at risk (22 plants, 2 nesting birds and 3 fish); ♦ shoreline erosion and degradation.

The River can be Reclaimed by...

♦ treating the municipal wastewater of the entire sector; ♦ reducing the toxicity of industrial discharges (since 1988, priority plants have reduced theirs by 75%); ♦ setting up a recreation and conservation network linked to the River and socio-economically important: Îles-de-Boucherville park, the Old Port, Parc des Îles (Notre-Dame and Sainte-Hélène islands), Bellerive and René-Lévesque boardwalks, etc.; promoting the Old Port, which had 5.2 million visitors in 1992 and $53.5 million worth of economic benefits (1990-92); ♦ protecting natural habitats (like aux Pins River, the Tailhandier flats and Île Verte).

Source: Technical reports and regional assessment report on Montreal–Longueuil sector, 1995. Environment Canada – Quebec Region, Environmental Conservation, St. Lawrence Centre. Reports on Priority Intervention Zone 9.

Environment Canada Environnement Canada

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March 1997

The St. Lawrence River – Priority Intervention Zone: Montreal–Longueuil

St. Lawrence Centre
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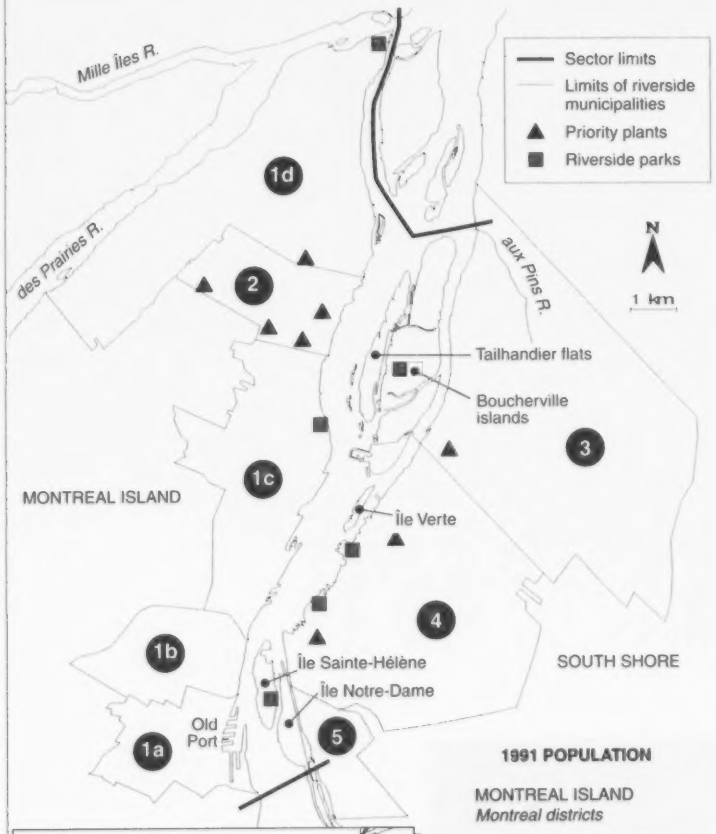
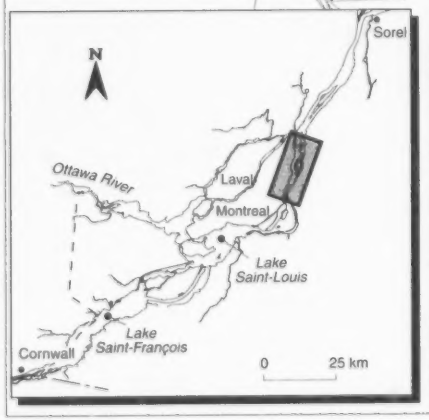
Saint-Laurent Vision 2000

ZIP 9 – MONTREAL–LONGUEUIL





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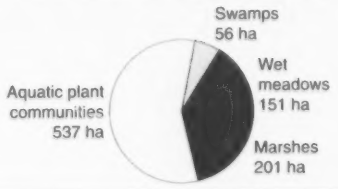

The Legacy of an Urban Lifestyle

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Source: Technical reports and regional assessment report on Montreal–Longueuil sector. 1995. Environment Canada – Quebec Region, Environmental Conservation, St. Lawrence Centre. Reports on Priority Intervention Zone 9.

Environment Canada Environnement Canada

Canada

March 1997

The St. Lawrence River – Priority Intervention Zone: Quebec City–Lévis

Here, the River...

♦ Is 48 km long and an average 3 km wide; ♦ has a discharge of 12 600 m³/s that is subject to strong tidal amplitude (4.8 m); ♦ and currents of 0.5 m/s to 1.5 m/s, depending on the tide; ♦ and which crosses a 1070-km², multi-vocational region.

A Natural Beauty...

♦ rich in diversified habitats that serve, among other things, as spawning and nesting grounds; ♦ home to a number of wildlife species: 300 birds and 71 fish; ♦ with major waterfowl flyways (Greater snow goose) and fish migration routes (American eel and Atlantic tomcod); ♦ and several colonial bird species: Ring-billed gull, Silver gull and Common tern; ♦ along with a number of species of concern: 12 plants, 7 fish, 3 nesting birds and 1 reptile species.

The Human Presence

♦ The area is made up of 23 riverside municipalities, of which 6 are part of the Quebec Urban Community (QUC); ♦ with two urban centres (Quebec City and Lévis); ♦ and urban sprawl facilitated by a widespread road network; ♦ four priority industrial plants of the St. Lawrence Vision 2000 action plan (pulp and paper and petrochemicals); ♦ and nine hazardous waste sites, primarily on the south shore; ♦ an important area for farming, forestry and cottaging.

A Big Part of Everyday Life, the River Figures...

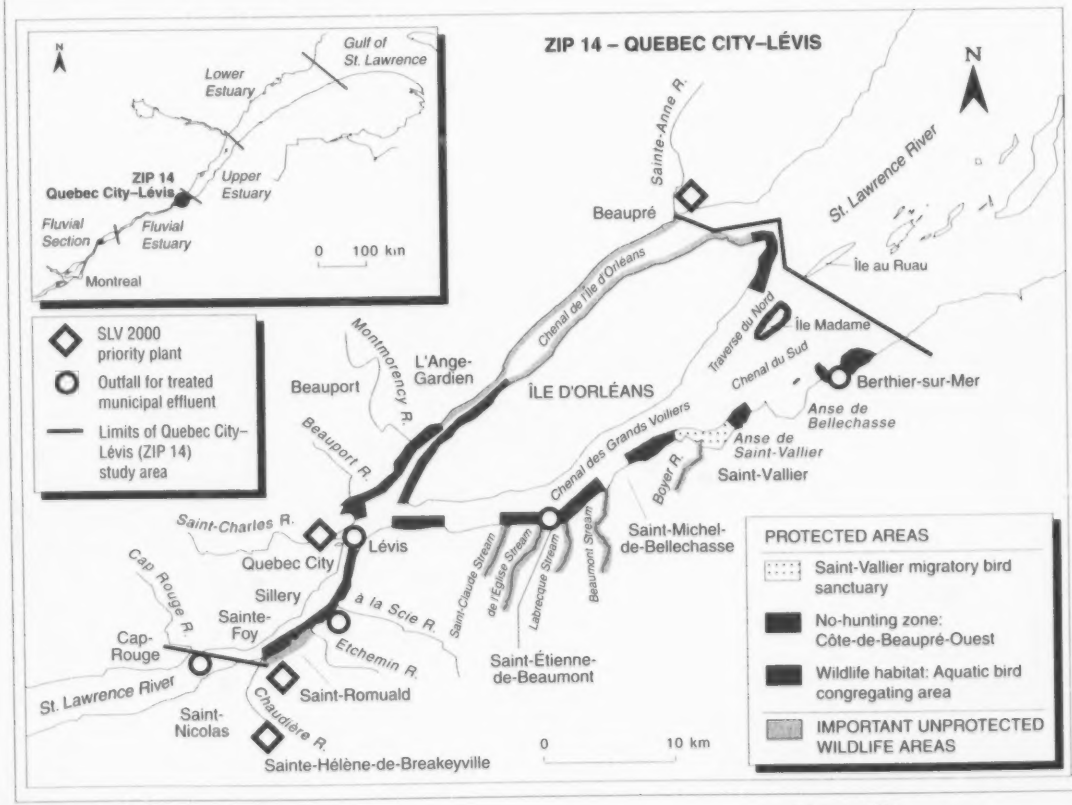
♦ in the commercial activities of the Port of Quebec, ranked second in the province in terms of goods handled: grain, ore, petroleum products; ♦ the many recreational and tourist attractions: Old Quebec (a UNESCO World Heritage Site), boating and river cruises; ♦ in supplying drinking water for 31% of the population; ♦ as a discharge site for municipal (93% of the population) and industrial wastewater; ♦ in the commercial fishery which, though past its heyday, remains important for the harvest of American eel.

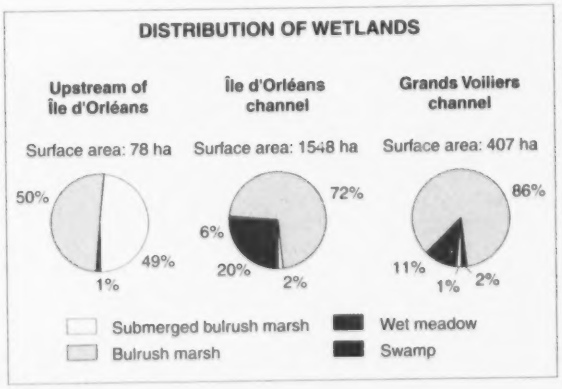
The Legacy of an Urban Lifestyle

♦ Water: bacteriological contamination of fecal origin; ♦ sediment contaminated by heavy metals, PAHs and PCBs in the Louise Basin and the estuary of the Saint-Charles River; ♦ uses compromised: swimming, fish consumption; ♦ disappearance of the smelt and Striped bass fisheries; ♦ some species expanding or problematic (Ring-billed gull, Zebra mussel); ♦ reduced accessibility to waterfront and degradation resulting from encroachment.

The River Can be Reclaimed by...

♦ reducing agricultural- and industrial-source pollution; ♦ treating municipal wastewater and containing sewer overflows; ♦ protecting and enhancing littoral ecosystems: Beaupré coast, eastern end of north bank of Île d'Orléans, Beauport flats; ♦ rehabilitating disturbed habitats and resources: (e.g. Rainbow smelt in the Boyer River); ♦ increasing access to the River: Old Port, Jacques-Cartier beach, Beauport beach and tributary mouths.





Source: Technical reports and regional assessment report on Quebec City–Lévis sector. 1995. Environment Canada – Quebec Region, Environmental Conservation, St. Lawrence Centre. Reports on Priority Intervention Zone 14.

St. Lawrence Centre
State of the Environment

Saint-Laurent Vision 2000

Environment Canada Environnement Canada

Canada

March 1997

The St. Lawrence River – The Action and Evolution of Ice

THE EXTENT AND THE THICKNESS OF THE ICE COVER ON the St. Lawrence River vary considerably from one year to the next depending on the winter climate. The formation, drift and dispersal of ice depend on a number of meteorological and oceanographic factors.

Ice formation

Ice begins forming during the first two weeks of December upstream of the Saguenay River. By month's end, the southern half of the St. Lawrence is iced over. At the beginning of January, the ice extends toward the southeastern gulf across the Strait of Honguedo. Ice forms in January along the Strait of Belle Isle, extending westward along the Côte-Nord. From January to the end of February, ice gradually covers almost the entire Gulf.

Fast ice (ice frozen fast to the shore) forms mainly along the coast, in bays, around islands and in unnavigable channels. Elsewhere in the Gulf, ice remains mobile throughout winter.

Ice movement and drift

Pushed by dominant northwesterly currents and winds, the ice that forms upstream of Quebec drifts eastward all winter long.

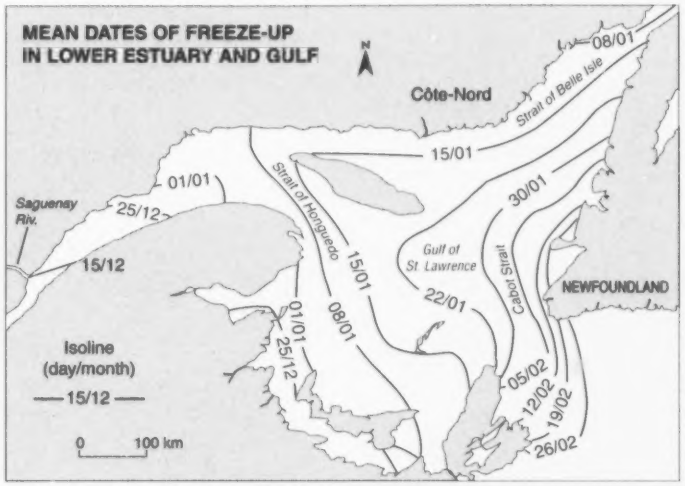
To prevent ice jams in the River, ice breakers intervene to keep the ice moving in the ship channel. Commercial shipping continues all winter as far as Montreal.

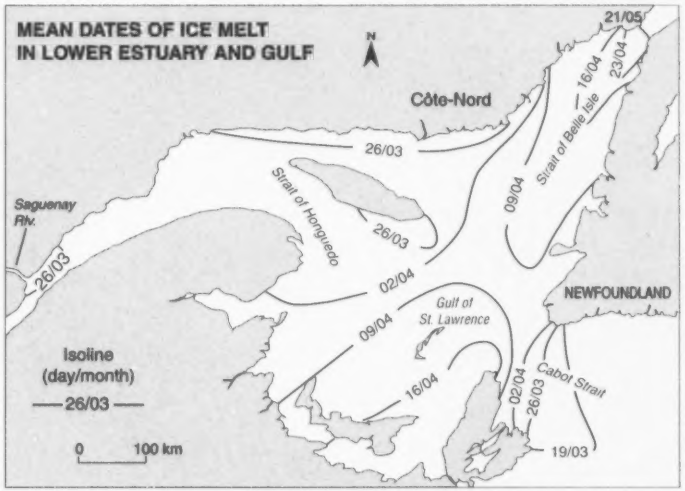
Ice melt

Ice usually begins to melt offshore in areas where currents are strongest around mid-March, extending shoreward in no particular pattern. The St. Lawrence is normally ice-free at the beginning of April except in the Gulf, where ice only disappears in May. The Strait of Belle Isle occasionally remains iced over until July. Small icebergs sometimes enter the Gulf through this strait, remaining along the Côte-Nord before disintegrating after 8 to 15 days.

ICE THICKNESS

In ports and sheltered bays, ice reaches a thickness of 45 to 85 cm, compared to 40 to 60 cm offshore. The ice just off Quebec City measured 126 cm thick on March 11, 1989, a record for the St. Lawrence River between 1961 and 1990.





Source:
- Bourget, E., D. Archambault, and P. Bergeron. 1985. Effet des propriétés hivernales sur les peuplements épibenthiques intertidaux dans un milieu subarctique, l'estuaire du Saint-Laurent. *The Canadian Naturalist* 112: 131-142.
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- Environment Canada. 1991. *Les conditions météorologiques maritimes dans le golfe du Saint-Laurent*. Atlantic Region, Bedford, N. S.
- Koutitonsky, V.G., and G.L. Bugden. 1991. The physical oceanography of the Gulf of St. Lawrence: A review with emphasis on the synoptic variability of the motion. In *The Gulf of St. Lawrence: Small Ocean or Big Estuary?* edited by J.-C. Therriault. Canadian Special Publication of Fisheries and Aquatic Sciences No. 113, pp. 57-90.

EXAMPLES OF ICE IN ACTION

Protection of riparian areas

- Ice that is fastened to the shore in winter offers protection from the erosive action of waves.
- Floating ice inhibits wave formation, thus reducing the probability of icy sprays. These icy sprays may cause vessel icing or hinder operations on deck.

Erosion and transport in riparian areas

- The effect of tides and the progressive freeze-up in winter cause large quantities of sediments and riparian boulders to be ripped up and incorporated into the forming ice. During spring break-up, ice, now floating, may transport and scatter this material on the shore as it melts, or carry it further away, depending on the wind and tide.
- During transport, ice and the rocky debris picked up by ice erode rocky banks by scraping, flattening and denuding the surface.

Impacts on biological organisms

- Cold and ice control the structure and assemblage of living organisms in areas subject to ice-induced erosion. During spring break-up, their abundance diminishes substantially.
- *Frazil* (ice crystals or granules forming a slushy "crust" on the water surface) is used by the Atlantic tomcod to lay its eggs.
- In some parts of the Gulf, floating ice serves as calving grounds for three seal species: the Greenland seal, the Grey seal and the Hooded seal.

Impact of ice on human activities

- Some riparian areas are subject to ice jams and flooding during spring break-up.
- Ice formation slows commercial shipping.
- Development of ice fishing and the halt of certain activities (e.g. water sports, cruises).

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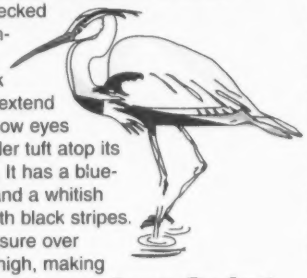
Environment Canada Environnement Canada

Canada

March 1997

The St. Lawrence River and the Great Blue Heron (*Ardea herodias*)

THE GREAT BLUE HERON IS A LONG-LEGGED wading bird of the Ardeidae family. This long-necked bird is distinguished by the black bands that extend from its yellow eyes to the slender tuft atop its white head. It has a blue-gray back and a whitish stomach with black stripes. Adults measure over one metre high, making this the largest heron in Canada. The Great blue heron can live for more than 15 years.



Distribution in North America

- This migratory bird is found from Alaska and Newfoundland down to Mexico and the Caribbean. It overwinters between southern British Columbia and the northern U.S. down to Panama, Colombia and into Venezuela.
- It is abundant on the outskirts of certain freshwater marshes and along the saltwater flats and marshes of the estuary and Gulf of St. Lawrence.
- The Great blue heron arrives at nesting sites in Quebec between the third week of March and the first week of April. It migrates south to overwinter from September to December.

Food

- Main food source: small fish.
- Secondary foods: crustaceans, insects, rodents, amphibians (especially frogs), reptiles, small birds and plant seeds.

Nesting habits

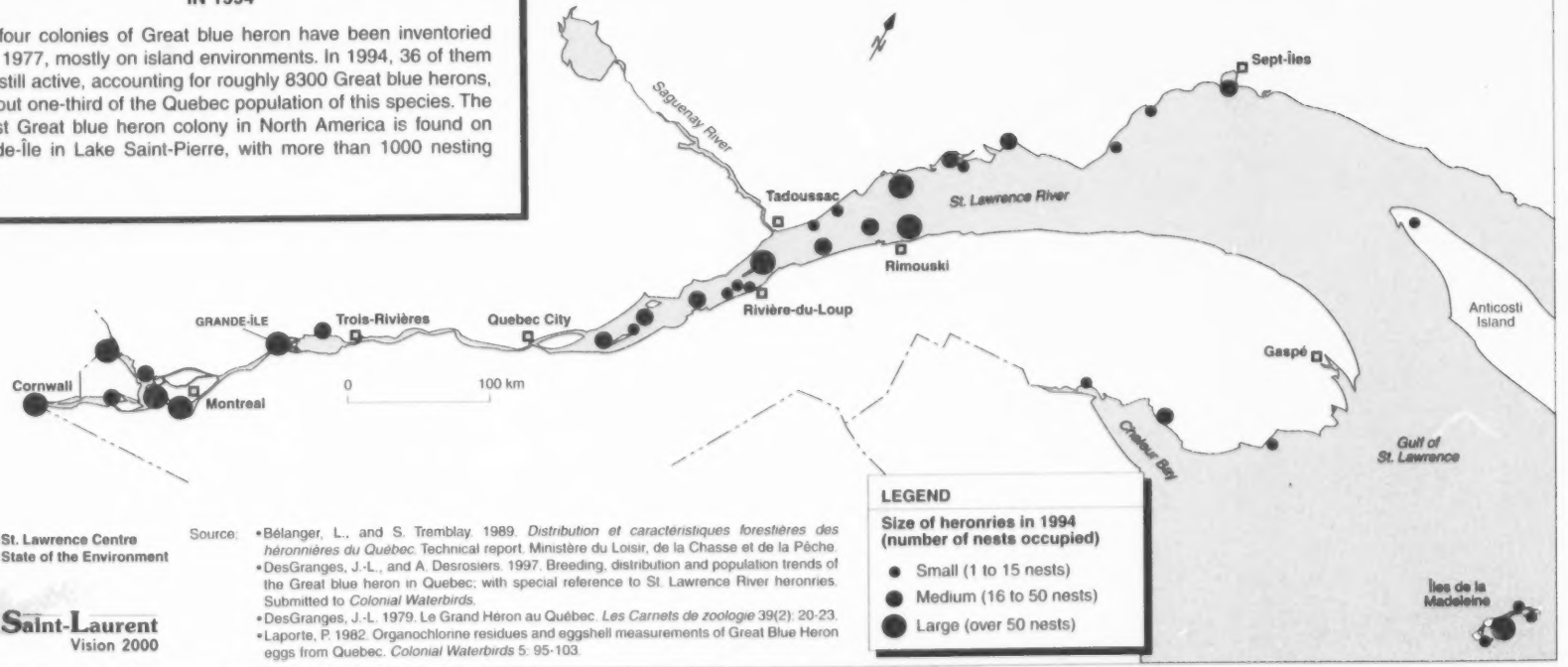
- Great blue herons nest in colonies known as heronries to which they return year after year to reproduce.
- Heronries are located in wooded areas that are difficult of access for humans and for land predators, in proximity to food sources. They tend to be found primarily on islands devoid of land predators.
- They sometimes live together with Black-crowned night herons and Double-crested cormorants.
- They nest near the peaks of tall trees (12–20 m) from which they have a panoramic view of their surroundings.
- Nesting: 3 to 7 eggs; 28-day incubation period shared by both parents. Chick fledging takes place sometime after the 56th and 60th day of birth.

Stress factors

- Loss of habitat due to filling or deforestation of shores and islands.
- Human activities causing disturbances during breeding season, which may provoke nest abandonment and lead to greater predation of eggs by crows, ravens, gulls, raptors and muskrats, or to the loss of eggs and young from prolonged exposure to excess heat or cold.
- Illegal hunting.
- Eggs contaminated by PCBs in concentrations that are generally low, yet higher in St. Lawrence heronries than elsewhere in Quebec. These concentrations are lower than those reported in the Great Lakes region.

HERONRIES ALONG THE ST. LAWRENCE RIVER IN 1994

Sixty-four colonies of Great blue heron have been inventoried since 1977, mostly on island environments. In 1994, 36 of them were still active, accounting for roughly 8300 Great blue herons, or about one-third of the Quebec population of this species. The largest Great blue heron colony in North America is found on Grande-Île in Lake Saint-Pierre, with more than 1000 nesting pairs.



St. Lawrence Centre
State of the Environment

Saint-Laurent Vision 2000

Source:
- Bélanger, L., and S. Tremblay. 1989. *Distribution et caractéristiques forestières des héronnières du Québec*. Technical report. Ministère du Loisir, de la Chasse et de la Pêche.
- DesGranges, J.-L., and A. Desrosiers. 1997. Breeding, distribution and population trends of the Great blue heron in Quebec: with special reference to St. Lawrence River heronries. Submitted to *Colonial Waterbirds*.
- DesGranges, J.-L. 1979. Le Grand Héron au Québec. *Les Carnets de zoologie* 39(2): 20-23.
- Laporte, P. 1982. Organochlorine residues and eggshell measurements of Great Blue Heron eggs from Quebec. *Colonial Waterbirds* 5: 95-103.

Environment Canada Environnement Canada

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March 1997

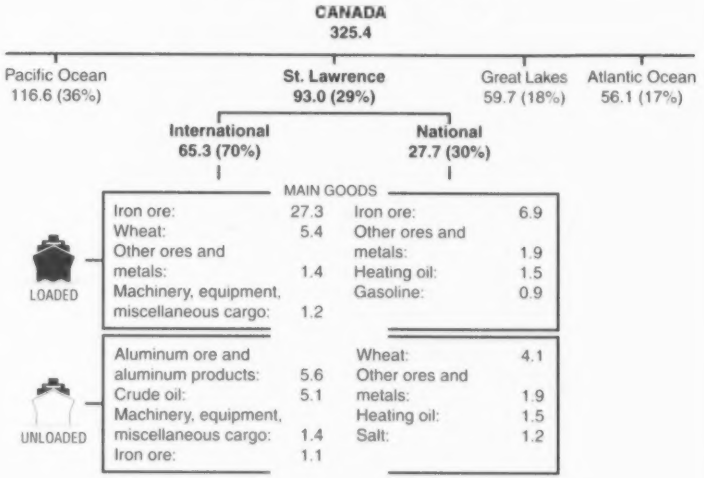
The St. Lawrence River – Main Commercial Ports (1993)

THERE ARE CLOSE TO 40 COMMERCIAL PORTS all along the St. Lawrence River. The volume of goods handled in these ports reached 93 million tonnes in 1993, or 29% of Canadian shipping traffic. The largest commercial ports are shown on the map below.

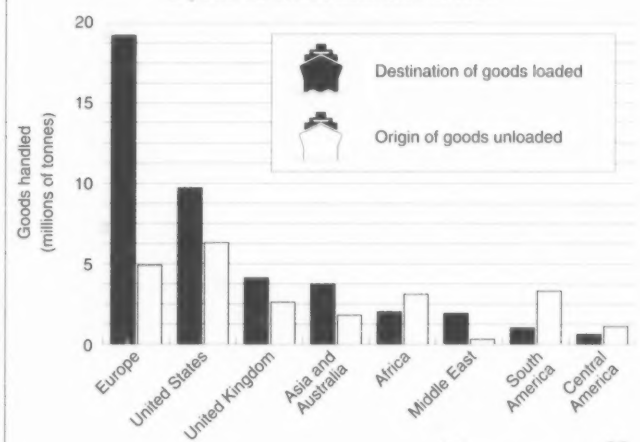
Eleven ports handle 98% of all goods transiting ports on the St. Lawrence, with each handling over one million tonnes annually. The seven other ports shown on the map below handled between 100 000 and one million tonnes of goods annually.

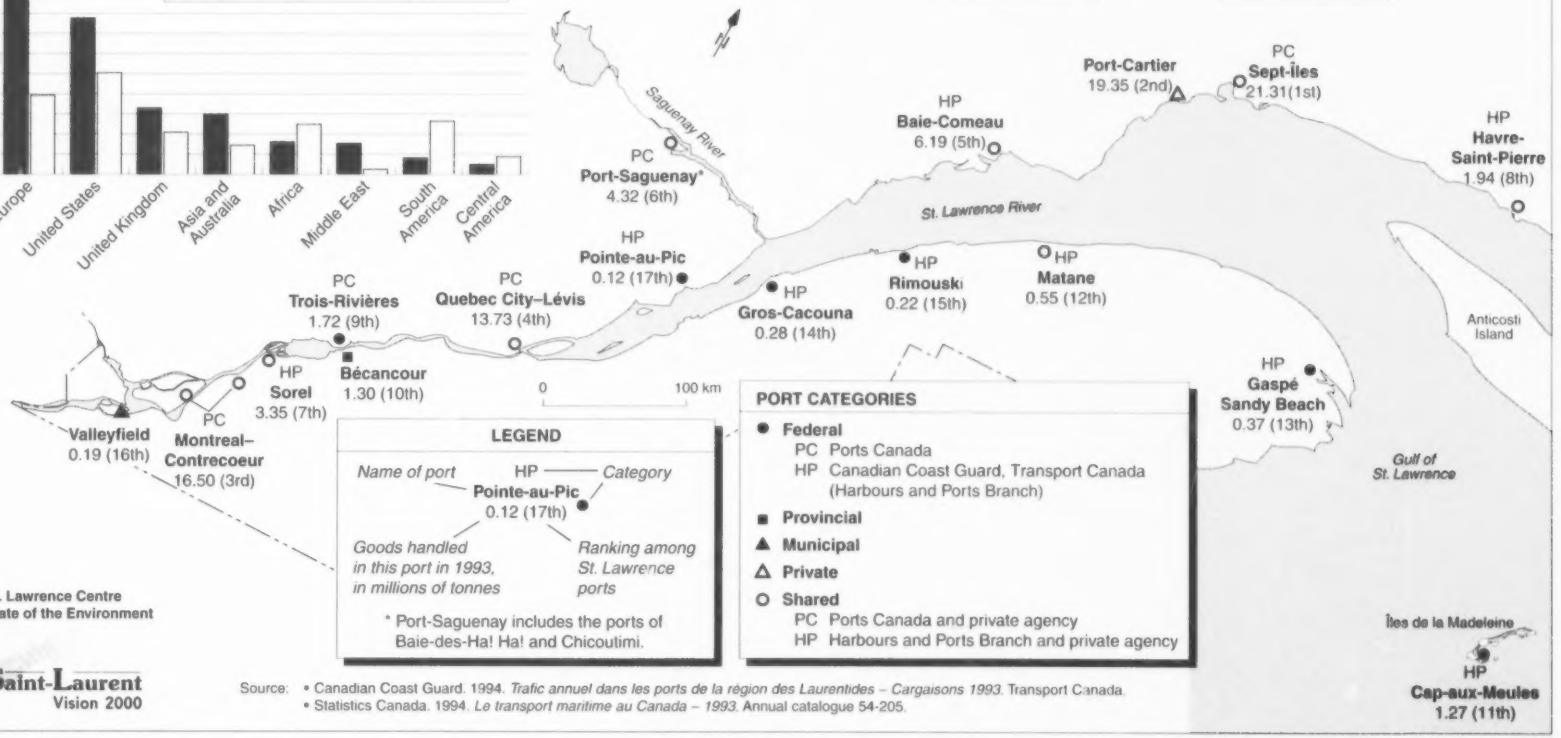
More than 6050 commercial vessels stopped at ports on the St. Lawrence in 1993. The port of Montreal–Contrecoeur received 22% of this traffic, followed by the ports of Quebec City–Lévis (11%), Sept-Îles (11%), Baie-Comeau (10%), Port-Cartier (8%), Matane (5%), Port-Saguenay (4%), Sorel (3%), and so on.

THE ST. LAWRENCE RIVER AND SHIPPING IN CANADA IN 1993
(millions of tonnes of goods handled)



INTERNATIONAL SHIPPING
Destination and origin of goods loaded and unloaded at ports on the St. Lawrence in 1993





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Source:
- Canadian Coast Guard. 1994. *Trafic annuel dans les ports de la région des Laurentides – Cargaisons 1993.* Transport Canada.
- Statistics Canada. 1994. *Le transport maritime au Canada – 1993.* Annual catalogue 54-205.

The St. Lawrence River – Priority Intervention Zone: The Saguenay

Here, the Saguenay...

♦ stretches over close to 170 km between Lake Saint-Jean and the St. Lawrence; ♦ laps at the shores of 21 municipalities with some 200 000 residents, mostly in four urban centres (Alma, Chicoutimi, Jonquière and La Baie); ♦ crosses a vast territory whose banks are primarily given over to recreation and tourism; ♦ and where the tide floods more than 2500 ha of mud flats harbouring a variety of freshwater, saltwater and brackish wetlands; ♦ is composed of a fluvial ecosystem (Saguenay River) and a marine ecosystem (Saguenay Fjord), separated by a transition zone (Saguenay estuary).

A River, an Estuary and a Fjord

♦ A river that transports an average of 1600 m^3/s of fresh water and over 160 000 t/y of sediments; ♦ an estuary where contact between fresh water and salt water creates a vast sediment deposition zone in the flats at Saint-Fulgence; ♦ a 275-m-deep fjord, characterized by the constant inflow of icy-cold, well-oxygenated salt water from the St. Lawrence River, teeming with a diversity of marine life.

An Ecosystem with...

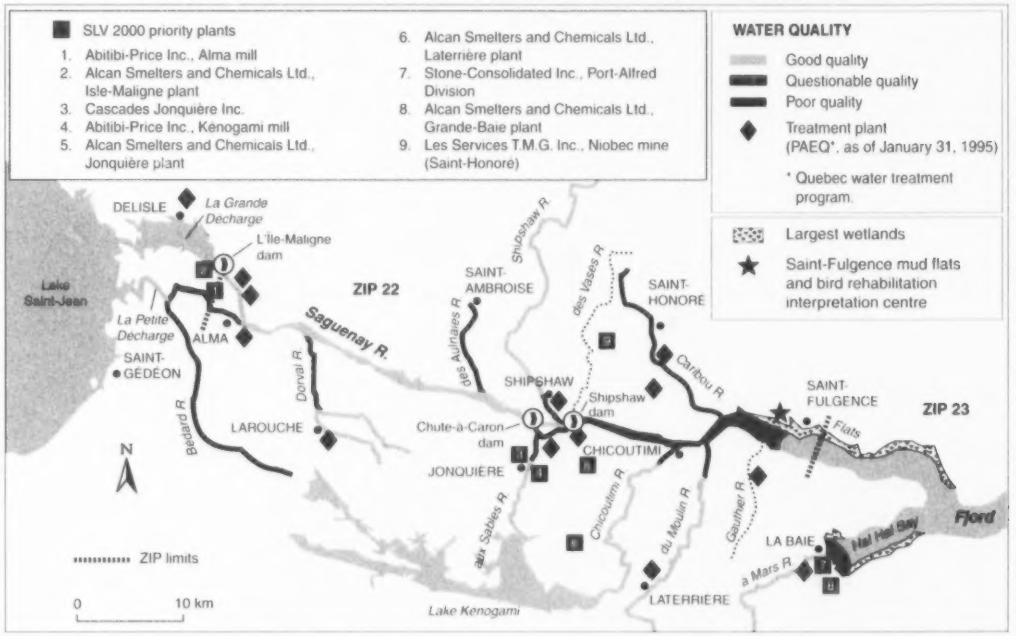
♦ more than 20 freshwater fish species (Walleye, perch, etc.), fifty-odd marine species (cod, redfish, etc.) and numerous anadromous fish species (smelt, salmon, etc.); ♦ more than 400 invertebrates, including crustaceans (crabs, shrimp, etc.) and shellfish (clams); ♦ more than 250 species of riparian plants, including Glasswort (*Salicornia europaea*), found regionally only in Saint-Fulgence; ♦ close to 300 bird species, concentrated mostly in Saint-Fulgence and La Baie; ♦ marine mammals such as the Harbour seal and Beluga whale; ♦ important wildlife habitats (including those protected by the Saguenay–St. Lawrence Marine Park and the Saguenay Park) along with species of concern: 6 fish, 7 birds and 2 mammals.

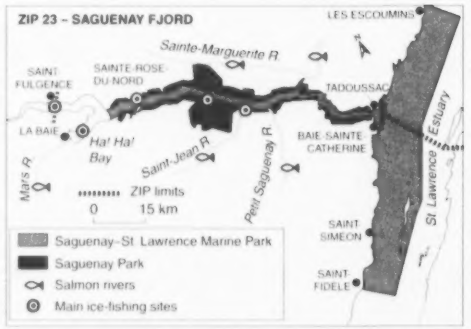
The Human Presence

♦ The Saguenay River supplies water to three generating stations with a combined force of over one million kW of electrical energy for industrial use; ♦ supplies drinking water: the towns of Alma and Delisle draw 16 000 m^3 daily from the Grande Décharge; the Abitibi-Price paper mill and Alcan in Alma draw their process water from the Saguenay River at a rate of 70 000 m^3/d; ♦ serves as a discharge site for municipal (more than 44% of untreated wastewater in 1995) and industrial (pulp and paper mills and aluminum smelters using the Söderberg process) wastewater; ♦ supports 600 ships transporting more than 4 million tonnes per year of various products (liquid and solid bulk goods: oil, bauxite, coke, alumina, etc.); ♦ is used for sport fishing from wharfs (smelt), in rivers (salmon, trout) and under ice (smelt, cod, redfish, etc.); ♦ and for pleasure boating, shoreline tourism and for scenic cruises and whale-watching excursions.

The Legacy of an Urban Lifestyle

♦ Water: the Saguenay River harnessed by means of hydro-electric dams; contamination by fecal coliforms, fertilizers and organic matter; ♦ fjord bed: sediments historically contaminated by mercury, PAHs and organic matter; ♦ soil: 16 hazardous-waste and contaminated-soil sites; ♦ air: PAH emissions from aluminum smelters using the Söderberg process; ♦ uses compromised: swimming, commercial fishing, consumption of fish and seafood, and shellfish harvesting.





Sustainable Enhancement of the Saguenay by...

♦ treating municipal wastewater, especially Chicoutimi's; ♦ reducing industrial waste by modernizing aluminum smelters and treating paper-mill effluent; ♦ monitoring the restoration of hazardous-waste and contaminated-soil sites; ♦ protecting wetlands and aquatic ecosystems; ♦ monitoring and rehabilitating animal populations: fish (smelt, cod) and marine mammals (Beluga whale); ♦ reconciling recreational and tourism development with environmental protection.

Source: Technical reports and regional assessment report on the Saguenay. 1995. Environment Canada – Quebec Region, Environmental Conservation, St. Lawrence Centre. Reports on Priority Intervention Zones 22 and 23.

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INFO-FLASH 88

The St. Lawrence River – Tributary Inputs of Organic Toxics (1991)

THE CHIMIOTOX INDEX

The Chimiotox Index was first developed to assess the reduction in toxic substances discharged in the effluent of the 50 priority industrial plants of the St. Lawrence Action Plan.

Chimiotox is a mathematical indicator based in quantitative and toxicological considerations. It is used to assess the relative importance of the toxic substances discharged in an industrial effluent or tributary of the St. Lawrence River. Daily quantities of each substance measured are converted into Chimiotox Units (CU) using a toxic weighting factor (F_{tox}) specific to each pollutant. This factor is the weighting assigned to a pollutant to assess its relative importance in the discharge, and was developed for each polluting substance based on the strictest water-quality criterion. Individual Chimiotox units for each substance are then added together to determine the Chimiotox Index (CI) of a given source for the substances analysed. The greater the Chimiotox Index, the higher the toxic discharge.

$$CU_A = Load_A \times F_{tox\ A}$$

$$CI_{tributary} = CU = CU_A + CU_B + CU_C + \ldots CU_Z$$

where

CU_A: Chimiotox unit of pollutant A at the mouth of the tributary;

$Load_A$: Quantity of pollutant A discharged into the St. Lawrence in a single day by the given source, in kilograms per day;

$F_{tox\ A}$: Toxic weighting factor of pollutant A;

$CI_{tributary}$: Chimiotox Index of pollutants A to Z measured at the mouth of the tributary.

The Chimiotox Index was used to assess inputs of ten toxic organic substances at the mouths of several tributaries of the St. Lawrence River.

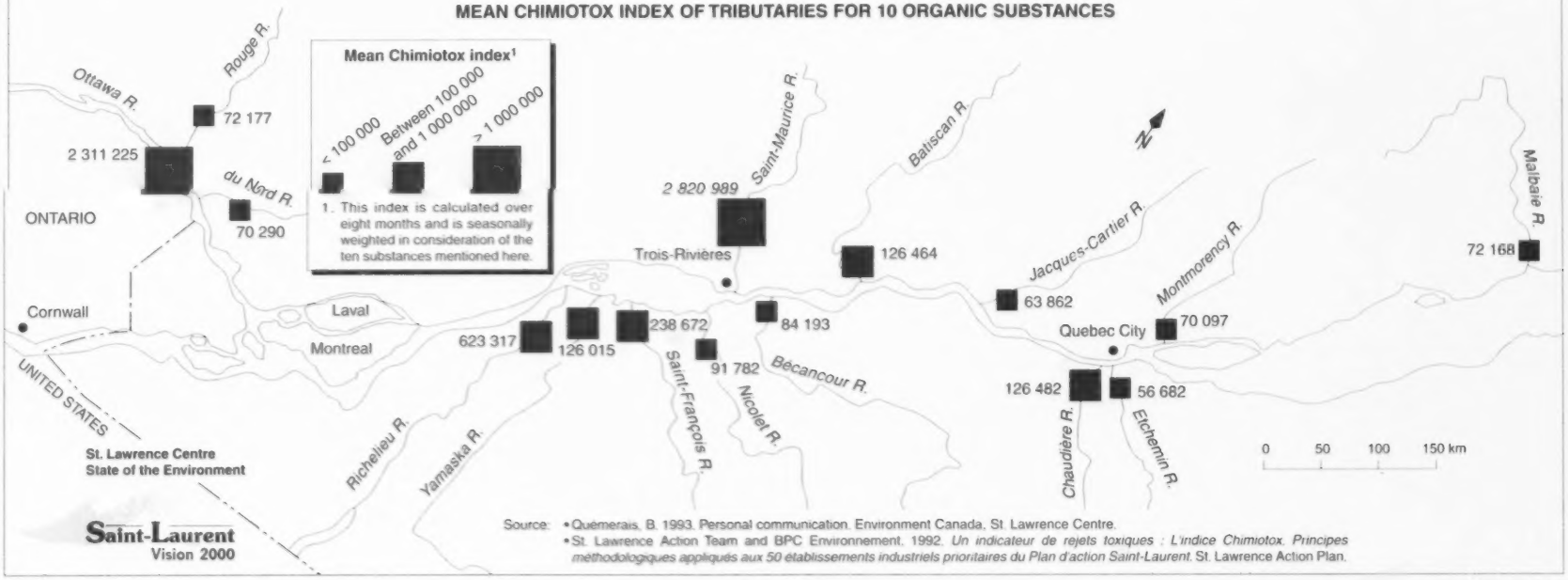
CLASSIFICATION OF TRIBUTARIES BY SEASONAL CHIMIOTOX INDEX FOR 10 ORGANIC SUBSTANCES*

Summer 1991		Autumn 1991	
• Ottawa	1 191 185	• Saint-Maurice (total)	5 769 375
• Saint-Maurice (downstream)	1 051 958	• Ottawa	4 177 956
• Richelieu	873 224	• Richelieu	206 802
• Saint-François	280 075	• Saint-François	169 663
• Chaudière	179 545	• Batiscan	147 092
• Yamaska	167 234	• Rouge	146 058
• Nicolet	132 584	• du Nord	129 248
• Batiscan	114 087	• Jacques-Cartier	97 977
• Malbaie	97 449	• Bécancour	84 905
• Bécancour	83 333	• Portneuf	70 796
• Etchemin	71 693	• St. Regis (Cornwall)	70 489
• L'Assomption	52 698	• Montmorency	70 096
• du Loup (Rivière-du-Loup)	47 476	• Sainte-Anne	66 309
• Jacques-Cartier	43 392	• Yamaska	57 318
• Sainte-Anne	36 808		

* The seasonal Chimiotox Index is the sum of each season's Chimiotox units for ten organic substances. Included in the organic substances measured are five classes of organic compounds: PAHs, PCBs, DDT, BHC and chlordane; and five organic substances: atrazine, diazinon, hexachlorobenzene, tetrachlorobenzene and pentachlorophenol.

Note: The table and map show only the 15 tributaries with the greatest organic toxic inputs (highest Chimiotox indexes).

MEAN CHIMIOTOX INDEX OF TRIBUTARIES FOR 10 ORGANIC SUBSTANCES



Source: • Quémerais, B. 1993. Personal communication. Environment Canada, St. Lawrence Centre.
• St. Lawrence Action Team and BPC Environnement, 1992. *Un indicateur de rejets toxiques : L'indice Chimiotox. Principes méthodologiques appliqués aux 50 établissements industriels prioritaires du Plan d'action Saint-Laurent.* St. Lawrence Action Plan.

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March 1997

The St. Lawrence River – Freshwater Phytoplankton from Cornwall to Port-Saint-François

St. Lawrence Centre
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PHYTOPLANKTON

Taken from the Greek *phuton* (plant) and *plagktos* (wandering), phytoplankton refers to all microscopic plant organisms (< 0.1 mm) living suspended in water. In the St. Lawrence River, phytoplankton is composed of several hundred different species of algae which drift in the current in the form of individual cells, filaments or colonies. They are classified on the basis of pigment (colour) and morphology (form).

Importance

Phytoplankton use light, inorganic carbon and the nutrients in water (phosphorus and nitrogen) to conduct photosynthesis, just as do larger algae, green terrestrial plants, mosses and lichen. Phytoplankton is one of the first links in the aquatic food chain and serves as animal food. Its small size, rapid reproduction rate (only a few days) and extraordinary diversity combine to make this algae a good indicator of the impact of pollutants on aquatic life.

Biomass

Phytoplankton abundance is measured by its biomass–that is, the total mass of living matter present at a given moment, calculated by volume (mg/L) or by surface area covered (mg/m²).

COMPOSITION AND TEMPORAL DISTRIBUTION OF PHYTOPLANKTON

To date, some 364 species of planktonic algae have been identified in the St. Lawrence River between Cornwall and Port-Saint-François. Of the species identified, 57% are **phytoplankton**, and 24% are **periphytons** (having been accidentally torn from their growing surface and ending up in the water column). Lastly, 19% are **indifferent species**, meaning they can live either in the water column or attached to a surface.

Seasonal composition and transport

The river's hydrodynamic regime governs the speed with which phytoplankton are carried downstream. During the spring freshet, more than 50% of identified species are present at all sampling stations on the St. Lawrence River, and less than 20% are exclusive to one station. During the low-water period, the slow current in turn slows the movement of the water downstream, augmenting the variances in plant species between sectors of the river. In summer and fall, therefore, 35% of the species are common to all sampling stations, and 35% are exclusive to one station.

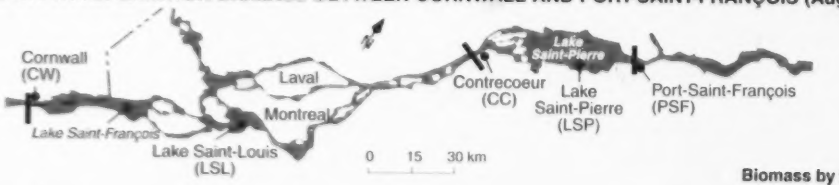
Phytoplankton biomass of the St. Lawrence River

The phytoplankton biomass in the St. Lawrence River is low, generally less than 2 µm/L. By comparison, phytoplankton biomass is greater than 50 µm/L in some major European rivers like the Seine or the Rhine. Highest biomass in the St. Lawrence River is observed in the spring, and the lowest is reported in summer.

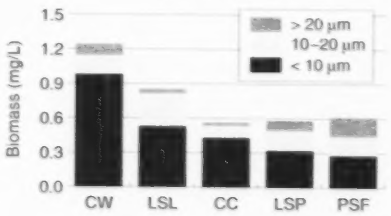
Taxonomic group	Number of species	Spring	Summer	Fall	Winter
Diatoms (Bacillariophyceae)	102	■			
Green algae (Chlorophyceae)	140		■		
Golden algae (Chrysophyceae)	41	■	■	■	
Flagellates (Cryptophyceae)	11	■	■	■	
Blue-green algae (Cyanophyceae)	46		■	■	
Peridinians (Dinophyceae)	13		■		
Euglena (Euglenophyceae)	11		■	■	
Total	**364**				

Legend: ■ Period of greatest abundance.

VARIATIONS IN PHYTOPLANKTON BIOMASS BETWEEN CORNWALL AND PORT-SAINT-FRANÇOIS (August 1991)



Biomass by size



General variations observed during August 1991

The reduced biomass shown in the above table corresponds to the decreased water transparency heading downstream and to increased suspended matter in the water.

Moving upstream to downstream, small algae (< 10 µm) become fewer in number as larger algae (> 20 µm) multiply. The taxonomic composition changes. This can be attributed, in part, to the passage of these waters through the fluvial lakes (Saint-François, Saint-Louis and Saint-Pierre).

Biomass at the stations studied is characterized by the predominance of small-size algae (< 10 µm) belonging to the groups of green algae, flagellates and diatoms.

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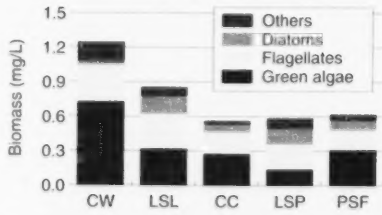

Flagellates (Cryptophyceae)

Unicellular algae having flagella with which they move in water.

Diatoms (Bacillariophyceae)

Unicellular brown algae having a silica shell. They are found in both fresh and salt water.

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INFO-FLASH 89

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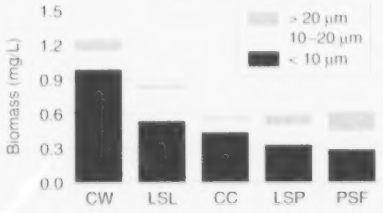

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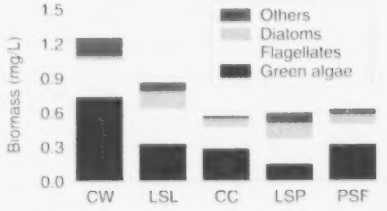

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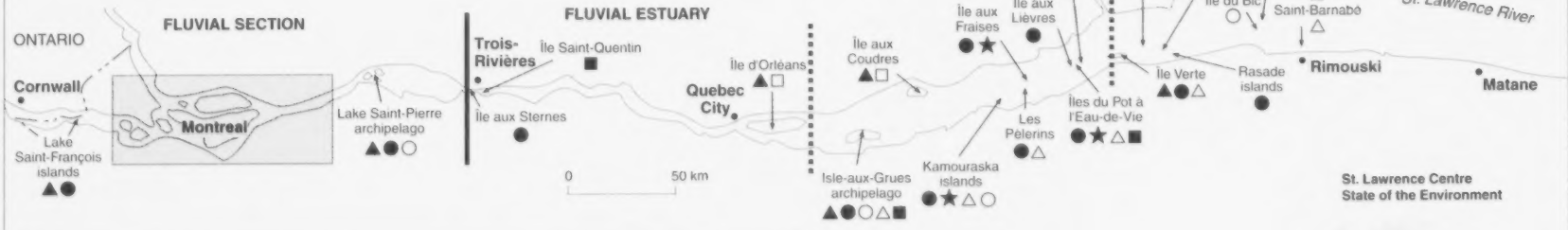
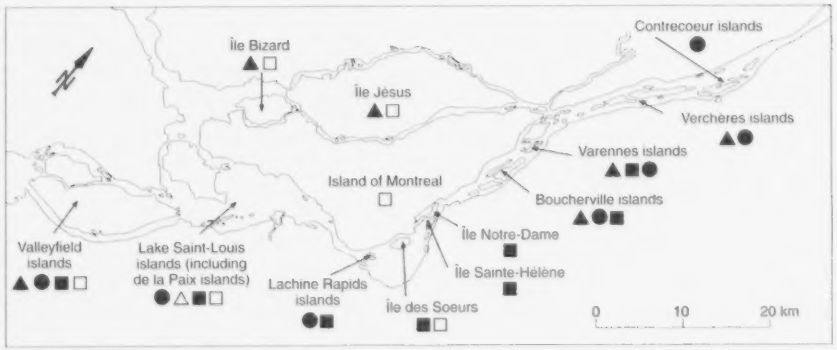
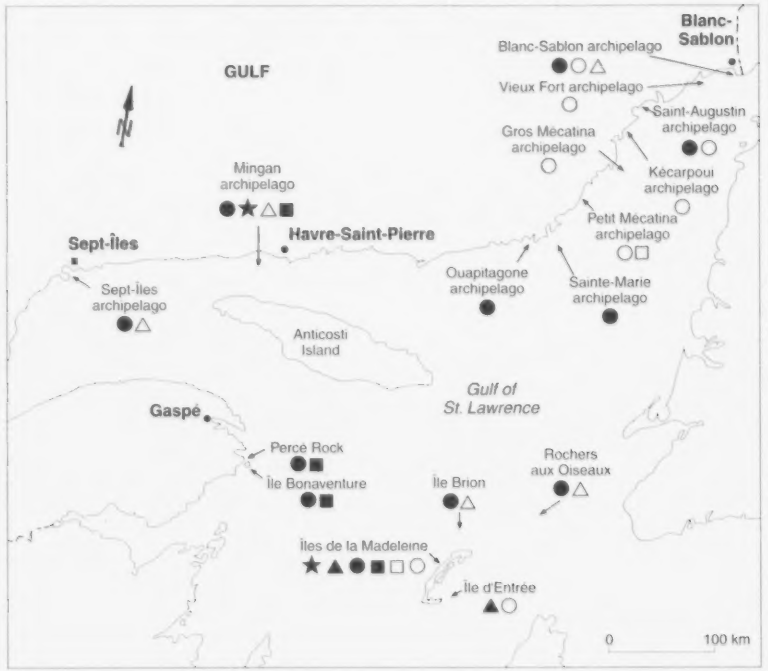
March 1997

The St. Lawrence River – Dominant Uses of Islands and Archipelagos

THE ST. LAWRENCE RIVER FROM CORNWALL TO BLANC-SABLON is made up of innumerable islands, some isolated, others in groups called archipelagos. From Cornwall to Quebec City, these islands are primarily urbanized and cultivated. Islands in the estuary and Gulf have generally remained devoid of settlement due to their relative isolation and harsh climate. These conditions, however, are favourable to many bird species and to a wide variety of plants and animals.







USE BY RIVER SECTOR

	Use	Number of islands or archipelagos: Fluvial Section	Fluvial Estuary	Upper Estuary	Lower Estuary	Gulf
▲	Agriculture	8	1	2	1	2
●	Conservation[a]	9	1	7	4	11
○	Hunting[b]	1	–	2	2	8
★	Harvesting[c]	–	–	3	1	2
△	Aids to navigation[d]	1	–	4	4	5
■	Recreation[e]	8	1	2	1	4
□	Urbanization	6	1	1	–	2

*In the case of archipelagos, the use applies to at least one island, and one island may comprise many uses.

a) National wildlife areas, migratory bird sanctuaries, migratory bird no-hunting zones, provincial conservation parks, wildlife preserves, ecological reserves, bird sanctuaries under the auspices of non-profit organizations.
b) Sport and subsistence hunting (aquatic birds and seals).
c) Harvesting of berries, eider down and shellfish.
d) Lighthouses, beacons.
e) Open-air activities, amusement parks and private campgrounds.

Source: De Repentigny, L.G. 1994. *Fichier insulaire du Saint-Laurent. Information générale sur les les îles du Saint-Laurent et ses principaux tributaires.* Canadian Wildlife Service, Environment Canada – Quebec Region, unpublished, in *River Islands and Shores*, Environmental Atlas of the St. Lawrence. 1996.

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March 1997

INFO-FLASH 91

The St. Lawrence River – Variations in the Water Level Upstream of Quebec City

THE ST. LAWRENCE RIVER and the Great Lakes form a complex system wherein changes in the water level or flow rate upstream of the basin have repercussions downstream. The Great Lakes chain ends in Lake Ontario, which empties into the St. Lawrence River.

The water level in a basin depends on the equilibrium between the amount of water entering (precipitation, runoff, groundwater) and the amount leaving (evaporation, discharge at outlet). This equilibrium changes with the season and from year to year, and may lead to flooding (high water) or to a period of extreme low water.

Following are the main factors influencing water level:

- *Natural factors:* precipitation, runoff, ice jams, tides, winds, evaporation, overgrowth of aquatic plants (may also be due to human activities).
- *Anthropic factors:* artificial regulation of flow rate, dredging, water diversion, water withdrawal.

Water Levels and the Ecosystem

Variations in the water level are a part of the natural seasonal cycle in temperate climes. The existence of this cycle, including a spring flood period and low water in summer, is necessary to promote and maintain broad animal and plant diversity. The flood plain is an essential habitat for many species of fish, as well as waterfowl and semi-aquatic animals like muskrats and frogs.

Both extreme events, when the water level is either very high or very low, and catastrophic changes disturb the ecosystem by exerting pressure on organisms whose life cycle is linked to water-level variations. The speed, frequency and duration of these phenomena and the time of year in which they occur will determine the effect of extreme water levels on riparian flora and fauna.

Reference Level

Sea level: zero level from which altitudes are measured. On maps of eastern Canada the reference level is located at Pointe-au-Père in the Gaspé.

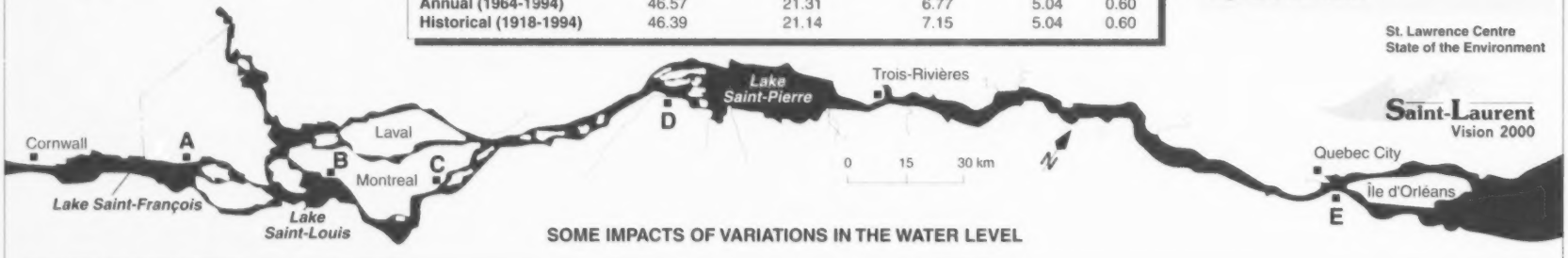
Mean water level (m)	A Coteau-Landing	B Pointe-Claire	C Port of Montreal	D Sorel	E Lauzon
Annual (1918-1963)	46.31	21.03	7.39	5.04	0.60
Annual (1964-1994)	46.57	21.31	6.77	5.04	0.60
Historical (1918-1994)	46.39	21.14	7.15	5.04	0.60

WATER LEVEL IN LAKE SAINT-FRANÇOIS

- *Determining factors:* artificial basin controlled by the Moses Saunders, Beauharnois and Coteau-du-Lac dams.
- Low rate of interannual variations (15 to 25 cm).

WATER LEVEL BETWEEN LAKE SAINT-FRANÇOIS AND LAUZON

- *Determining factors:* inputs of water from the Great Lakes and the Ottawa River. Local effects of precipitation, wind, ice jams and tides.
- Sudden fluctuations in water level and interannual deviations greater than one metre.
- Thirty-year cycle between periods of high and low water.



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SOME IMPACTS OF VARIATIONS IN THE WATER LEVEL

RESOURCE OR ACTIVITY AFFECTED	HIGH WATER	LOW WATER
Flow rate	Increased flow rate. Dilution of some contaminants.	Decreased flow rate. Concentration of some contaminants.
Shores	Flooding. Increased shoreline erosion.	Low water period. Possibility of shoreline being overrun by terrestrial plants or by urban, industrial or agricultural development.
Sediments	Recirculation of some contaminated sediments or possible contamination of wildlife.	Greater sediment deposition in certain areas.
Wildlife habitats and resource exploitation	Loss of habitats or decrease in size of some breeding grounds (reptiles, fish and waterfowl). Decreased wildlife populations. Dieback of riparian forests.	Reduction of waterfowl feeding grounds. Decreased size and inaccessibility of spawning grounds. Modified fish migration patterns. Excessive growth of aquatic plants. Difficulties for fishers at some catch sites.
Beaches and swimming	Decreased beach area.	Increased beach area. Possible overgrowth of bacteria as a result of temperature increase. Swimming disrupted.
Human land use (farming, riverfront properties, etc.)	Diminished farmland. Flood damage to property.	Appearance marred (bare shores).
Commercial and pleasure boating	Submersion of some wharfs.	Difficulties for commercial ships. Inaccessibility of pleasure-boating facilities. Increased possibility of running aground.
Electricity production	Increased hydroelectric production.	Decreased hydroelectric production.

Source:
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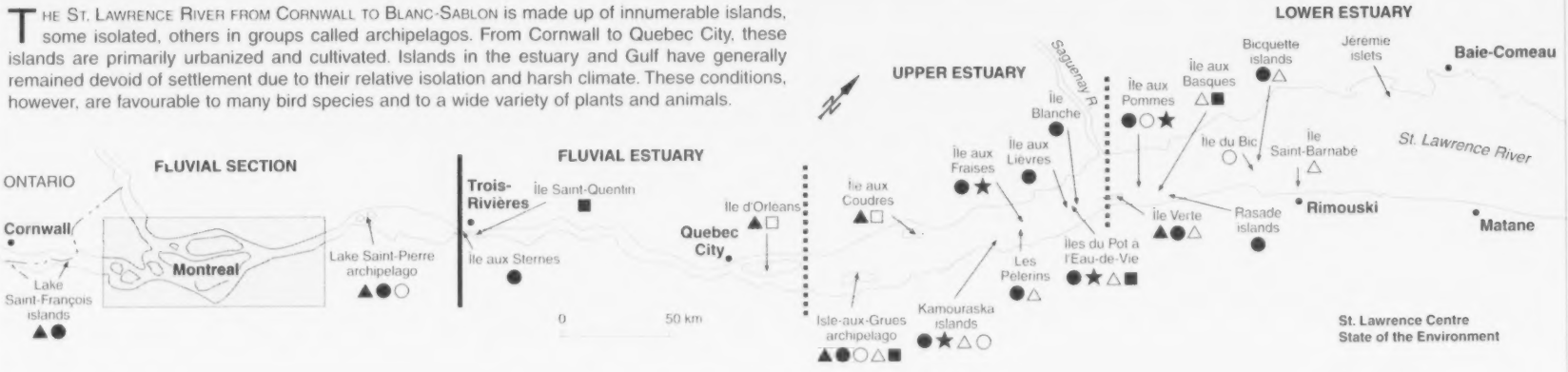
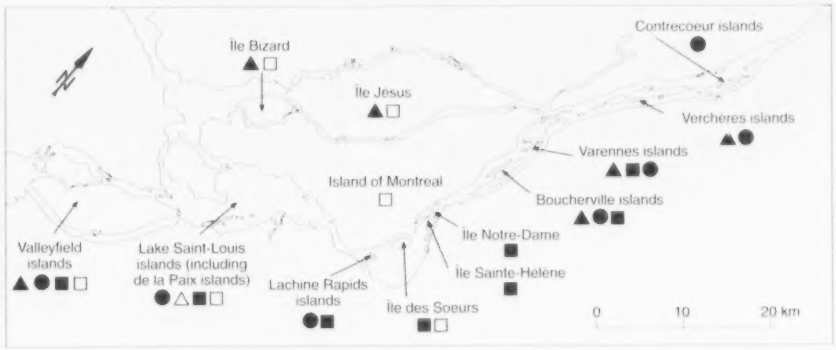
The St. Lawrence River – Dominant Uses of Islands and Archipelagos

THE ST. LAWRENCE RIVER FROM CORNWALL TO BLANC-SABLON is made up of innumerable islands, some isolated, others in groups called archipelagos. From Cornwall to Quebec City, these islands are primarily urbanized and cultivated. Islands in the estuary and Gulf have generally remained devoid of settlement due to their relative isolation and harsh climate. These conditions, however, are favourable to many bird species and to a wide variety of plants and animals.





USE BY RIVER SECTOR

	Use	Number of islands or archipelagos: Fluvial Section	Fluvial Estuary	Upper Estuary	Lower Estuary	Gulf
▲	Agriculture	8	1	2	1	2
●	Conservation[a]	9	1	7	4	11
○	Hunting[b]	1	–	2	2	8
★	Harvesting[c]	–	–	3	1	2
△	Aids to navigation[d]	1	–	4	4	5
■	Recreation[e]	8	1	2	1	4
□	Urbanization	6	1	1	–	2

*In the case of archipelagos, the use applies to at least one island, and one island may comprise many uses.

a) National wildlife areas, migratory bird sanctuaries, migratory bird no-hunting zones, provincial conservation parks, wildlife preserves, ecological reserves, bird sanctuaries under the auspices of non-profit organizations.
b) Sport and subsistence hunting (aquatic birds and seals).
c) Harvesting of berries, eider down and shellfish.
d) Lighthouses, beacons.
e) Open-air activities, amusement parks and private campgrounds.

Source: De Repentigny, L.G. 1994. *Fichier insulaire du Saint-Laurent. Information generale sur les les iles du Saint-Laurent et ses principaux tributaires.* Canadian Wildlife Service, Environment Canada – Quebec Region, unpublished, in *River Islands and Shores*, Environmental Atlas of the St. Lawrence, 1996.

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The St. Lawrence River – Variations in the Water Level Upstream of Quebec City

The St. Lawrence River and the Great Lakes form a complex system wherein changes in the water level or flow rate upstream of the basin have repercussions downstream. The Great Lakes chain ends in Lake Ontario, which empties into the St. Lawrence River.

The water level in a basin depends on the equilibrium between the amount of water entering (precipitation, runoff, groundwater) and the amount leaving (evaporation, discharge at outlet). This equilibrium changes with the season and from year to year, and may lead to flooding (high water) or to a period of extreme low water.

Following are the main factors influencing water level:

- *Natural factors:* precipitation, runoff, ice jams, tides, winds, evaporation, overgrowth of aquatic plants (may also be due to human activities).
- *Anthropic factors:* artificial regulation of flow rate, dredging, water diversion, water withdrawal.

Water Levels and the Ecosystem

Variations in the water level are a part of the natural seasonal cycle in temperate climes. The existence of this cycle, including a spring flood period and low water in summer, is necessary to promote and maintain broad animal and plant diversity. The flood plain is an essential habitat for many species of fish, as well as waterfowl and semi-aquatic animals like muskrats and frogs.

Both extreme events, when the water level is either very high or very low, and catastrophic changes disturb the ecosystem by exerting pressure on organisms whose life cycle is linked to water-level variations. The speed, frequency and duration of these phenomena and the time of year in which they occur will determine the effect of extreme water levels on riparian flora and fauna.

Reference Level

Sea level: zero level from which altitudes are measured. On maps of eastern Canada the reference level is located at Pointe-au-Père in the Gaspé.

Mean water level (m)	A Coteau-Landing	B Pointe-Claire	C Port of Montreal	D Sorel	E Lauzon
Annual (1918-1963)	46.31	21.03	7.39	5.04	0.60
Annual (1964-1994)	46.57	21.31	6.77	5.04	0.60
Historical (1918-1994)	46.39	21.14	7.15	5.04	0.60

WATER LEVEL IN LAKE SAINT-FRANÇOIS

- *Determining factors:* artificial basin controlled by the Moses Saunders, Beauharnois and Coteau-du-Lac dams.
- Low rate of interannual variations (15 to 25 cm).

WATER LEVEL BETWEEN LAKE SAINT-FRANÇOIS AND LAUZON

- *Determining factors:* inputs of water from the Great Lakes and the Ottawa River. Local effects of precipitation, wind, ice jams and tides.
- Sudden fluctuations in water level and interannual deviations greater than one metre.
- Thirty-year cycle between periods of high and low water.

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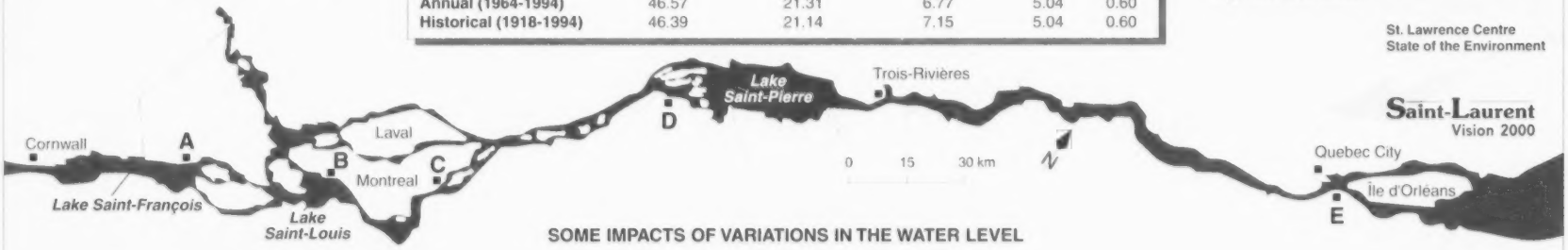

SOME IMPACTS OF VARIATIONS IN THE WATER LEVEL

RESOURCE OR ACTIVITY AFFECTED	HIGH WATER	LOW WATER
Flow rate	Increased flow rate. Dilution of some contaminants.	Decreased flow rate. Concentration of some contaminants.
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The St. Lawrence River – Water Regulation in the Montreal Region

REGULATION OF THE ST. LAWRENCE RIVER

THE NATURAL HYDROLOGIC REGIME of the St. Lawrence–Great Lakes basin has been modified by the introduction of several flow-control structures and the implementation of water regulation policies. Changes in the water level or flow rate upstream of this basin can be felt downstream. The Great Lakes chain of waterbodies empty into eachother, starting with Lakes Superior and Michigan, and ending in Lake Ontario, which flows into the St. Lawrence River.

What is Regulation?

A body of water becomes regulated through the control of its flow (or discharge) rate for the purpose of obtaining more favourable levels for various interests, in consideration of flooding and low-water periods. The flow rate at the outlet of Lake Ontario, heading in the direction of the St. Lawrence River, is the result of current and projected inputs, as determined by a Canada–U.S. agreement. In force since 1963, this agreement has stabilized the water level of Lake Ontario while controlling water levels upstream and downstream so as to limit the flood damage to riverfront property, encourage electricity production, and ensure a minimum depth for commercial ships and pleasure boats.

Consequences of Water Regulation

The purpose of water regulation is to reduce and/or balance the severity of the impacts of flooding and low water. However, water regulation does not guarantee total control over water levels because natural factors, which may modify the input of water into a basin, can not be controlled or predicted with any long-term accuracy. For instance, floods may still occur because inputs of water into the basin may exceed its water-eliminating capacity.

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DIAGRAM OF THE HYDROGRAPHIC NETWORK OF THE MONTREAL REGION

1 Iroquois dam
2 Long-Sault dam
3 Moses Saunders dam and generating station
4 Coteau dams
5 Île Juillet dam
6 Saint-Timothée dam
7 Les Cèdres dam and generating station
8 Pointe-du-Buisson dam
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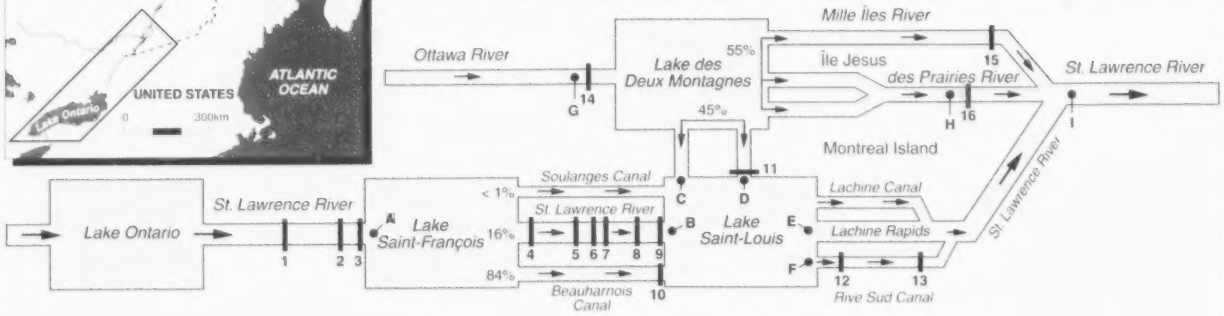

CONTROL AGENCIES

FLOW RATES AND WATER LEVELS are managed by the International Joint Commission (IJC), a bilateral agency charged with applying the treaty on boundary waters signed between Canada and the United States in 1909.

The International St. Lawrence River Board of Control, created in 1952 by the IJC, is responsible for implementation of the 1958-D Plan, which regulates Lake Ontario. Upstream of Lake Saint-François, three dams (the Moses Saunders, Long-Sault and Iroquois dams) serve to regulate flows between Lake Ontario and Cornwall. A Quebec–Ontario agreement determines the water level in Lake Saint-François. The board is currently studying two new regulation plans (35-P and IS-4) in an attempt to better satisfy the needs of both Lake Ontario and St. Lawrence River interests. These new plans were designed in consideration of a criterion aimed at conserving natural ecosystems.

Location	Mean annual flow rate (m^3/s)	Year
A Cornwall	7 720	1986–1990
Inlet of Lake Saint-Louis		
B Beauharnois Canal and St. Lawrence	8 063	1980–88
C Vaudreuil channel	336	1980–89
D Sainte-Anne channel	549	1980–89
Outlet of Lake Saint-Louis		
E Lachine Rapids (LaSalle)	9 047	1980–89
F Rive Sud Canal	135	1980–89
G Carillon Dam	1 935	1980–89
H Rivière-des-Prairies Dam	1 067	1980–88
I St. Lawrence downstream of Montreal	10 588	1980–85

MAIN CONTROL STRUCTURES

Commissioned	Control structure
1906	Soulanges canal (up to 1959)
1914–1924	Les Cèdres dam and generating station
1929	Rivière-des-Prairies dam and generating station
1931	Submerged dikes between the Sorel islands
1932	Beauharnois dam and generating station
1933–1943	Coteau dams
1941	Île Juillet regulating dams
1958	Moses Saunders dam and generating station (Ontario)
1962	Pointe-du-Buisson dam
	Carillon dam and generating station
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1965	Saint-Timothée dam
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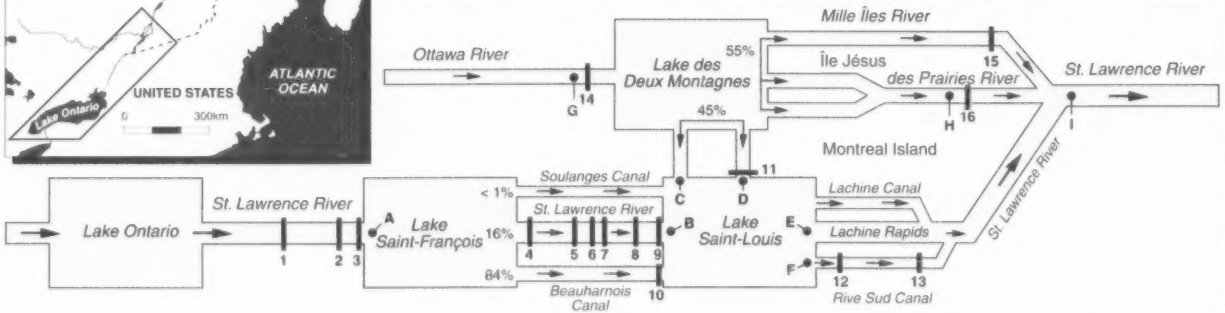

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The St. Lawrence River – Priority Intervention Zone: The Lower Estuary

The Estuary is...

♦ 230-km long, occupying an area of 9250 km²; ♦ an underwater topography dominated by the Laurentian Channel, a deep, U-shaped trough bordered on either side by a relatively flat littoral shelf; ♦ with a deepwater upwelling which makes the surface waters icy and nutrient-rich.

A Marine Ecosystem With...

♦ a diversity of rich habitats for nesting, spawning and calving; ♦ an abundance of wildlife: more than 800 benthic invertebrates, close to 80 fish species, over 300 bird species, and 14 marine mammals; ♦ major migratory corridors for several fishes, including the American eel and Atlantic tomcod; ♦ close to 130 bird colonies; ♦ large congregations of nesting Common eiders; ♦ a number of species of concern: 12 vascular plants, 7 fish, 15 birds (including 6 nesters), 1 reptile, and 4 mammals (including 4 marine mammals).

The Human Presence

♦ 44 riverside municipalities and two Native Indian reserves made up a total population of 127 801 in 1991; ♦ there are three urban centres—Baie-Comeau, Rimouski, and Matane—accounting for 54% of the population living along the coast of the Lower Estuary; ♦ wastewater treatment plants serve 77% of the population; ♦ the forest industry dominates regional land use (60%), the rate of urbanization is low (3%), and there is a rural area exclusive to the south shore (28%); ♦ industrial activities are concentrated near Baie-Comeau; ♦ four priority plants can be found (3 pulp and paper mills, 1 aluminum smelter).

A Big Part of Everyday Life, the Estuary is Used...

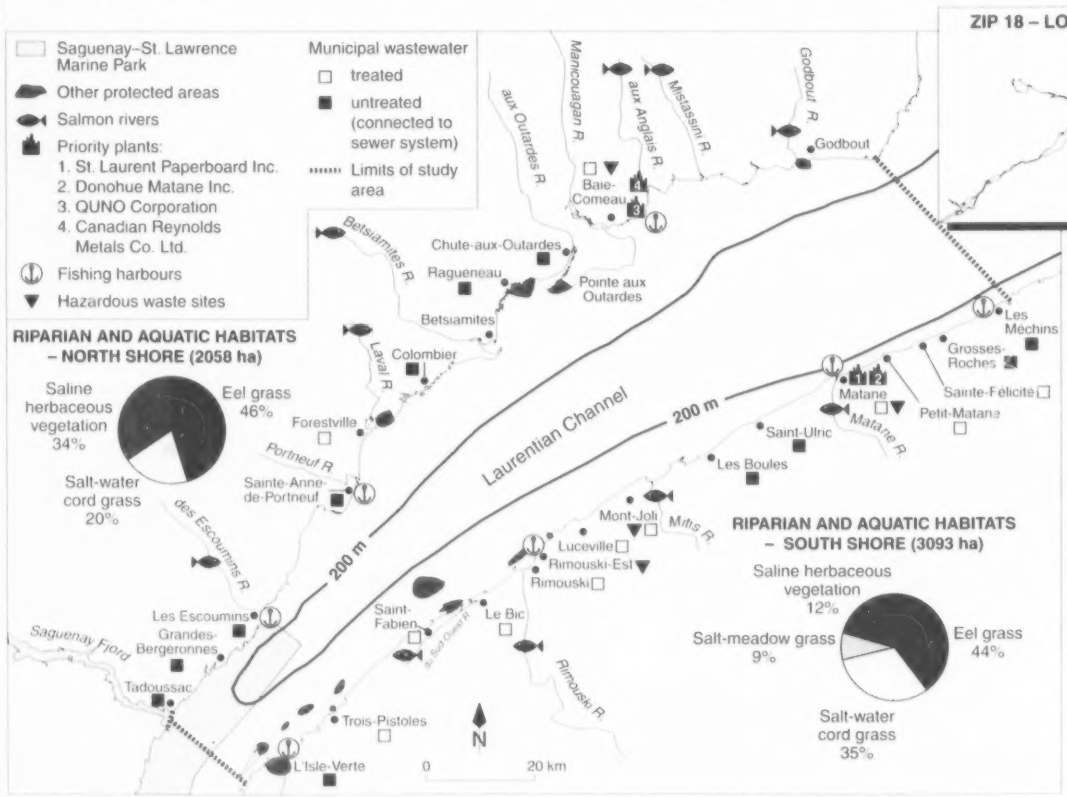
♦ for fishing and shipping (three of the largest fishing harbours in Quebec, at Matane, Rimouski-Est and Baie-Comeau); ♦ for the many natural tourist attractions (Saguenay–St. Lawrence Marine Park, Saguenay and Bic provincial parks, salmon rivers, national wildlife areas, migratory bird sanctuaries); ♦ for the many tourist activities linked to the St. Lawrence River (bird and whale watching, pleasure boating, sea fishing, underwater diving); ♦ for commercial fishing (Snow crab, shrimp, Greenland halibut, whelks and herring—about 10% of all landings in Quebec, or more than 4600 tonnes and $20 million in 1995); ♦ for shellfish harvesting.

The Legacy of Development

♦ Water: localized bacterial contamination; ♦ sediment highly contaminated in Baie des Anglais (PCBs, PAHs), and in the port of Forestville (PAHs); ♦ birds and marine mammals contaminated by PCBs, organochlorine compounds and mercury; ♦ restrictions on the consumption of shellfish, seal meat and other marine products from Baie des Anglais; ♦ overfishing of a number of commercial species like cod and Greenland halibut; ♦ reduced access to and degradation of the shoreline (646 ha of habitat filled, drained or dredged); ♦ the erection of dams on the aux Outardes and Manicouagan rivers, with damaging effects on the aquatic wildlife (Beluga whale, anadromous fish); ♦ 5 hazardous-waste disposal sites; ♦ a few urban areas located in flood zones.

Sustainable Development Means...

♦ treating municipal wastewater and capturing sewer overflow water; ♦ reducing household and agricultural pollution, especially near shellfish beds; ♦ protecting and enhancing littoral ecosystems; ♦ rehabilitating habitats and resources; ♦ increasing access to the St. Lawrence; ♦ reconciling tourism development with environmental protection.



Source: Technical reports and regional assessment report on the Lower Estuary. 1996. Environment Canada – Quebec Region, Environmental Conservation, St. Lawrence Centre. Reports on Priority Intervention Zones (ZIP) 18.

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INFO-FLASH 94

The St. Lawrence River – State of the Riverbanks from Dundee to Île d'Orléans (1994)

FLUVIAL SECTION

UPSTREAM

Riverbanks (474 km): 80% degraded, 20% natural

- The most degraded section (80%) along the River.
- Of the 96 km of natural riverbank, 41% is affected by erosion.
- The remaining 59% (57 km) is stable, but makes up only 12% of total shore area.

Banks (km)		Degraded (%)	Natural (%)
North	130	87	13
South	188	85	15
Islands	156	67	33

DOWNSTREAM

Riverbanks (573 km), 20% degraded, 80% natural

- The most natural section along the River (456 km).
- Highest rate of eroded natural banks (59%) due to the presence of several islands which have not been subject to bank stabilization work.
- The remaining 41% of natural riverbank (189 km, or 33% of the 573 km of shoreline) is stable.

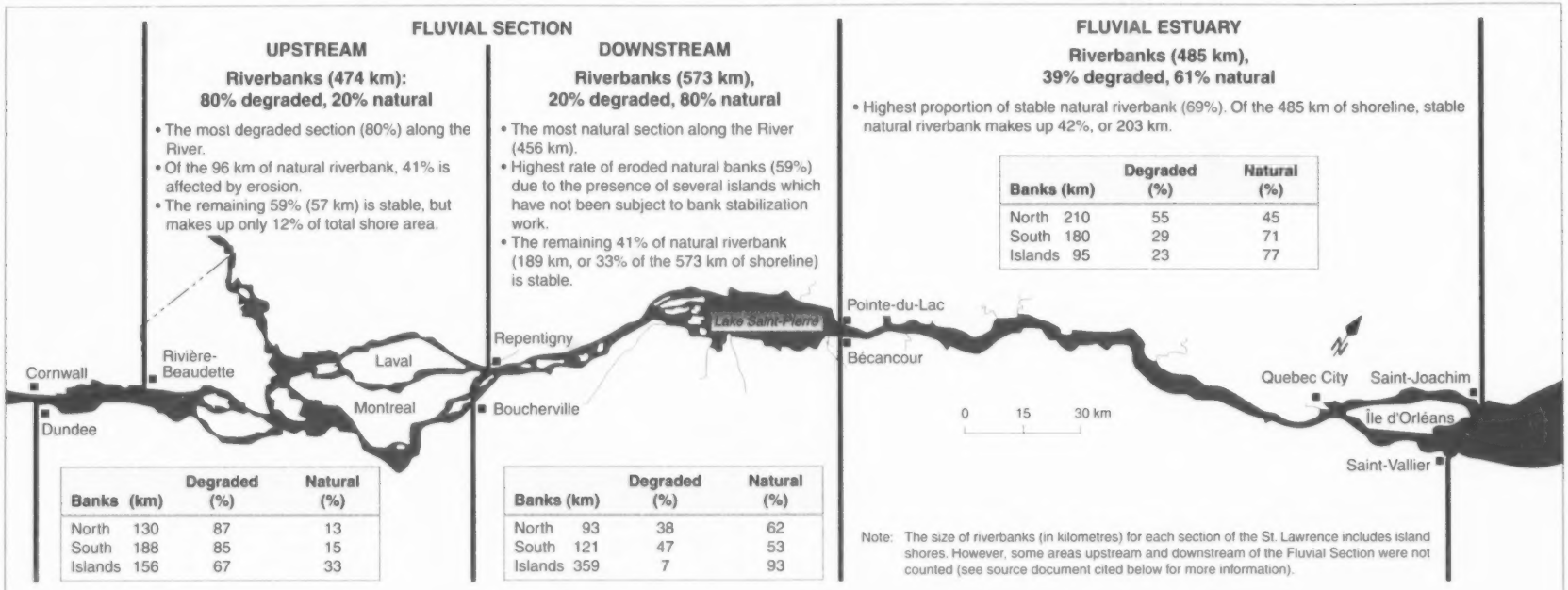
Banks (km)		Degraded (%)	Natural (%)
North	93	38	62
South	121	47	53
Islands	359	7	93

FLUVIAL ESTUARY

Riverbanks (485 km), 39% degraded, 61% natural

- Highest proportion of stable natural riverbank (69%). Of the 485 km of shoreline, stable natural riverbank makes up 42%, or 203 km.

Banks (km)		Degraded (%)	Natural (%)
North	210	55	45
South	180	29	71
Islands	95	23	77



Note: The size of riverbanks (in kilometres) for each section of the St. Lawrence includes island shores. However, some areas upstream and downstream of the Fluvial Section were not counted (see source document cited below for more information).

IMPORTANCE OF RIPARIAN ENVIRONMENTS

Riparian wetlands are essential habitats for a multitude of plants, fish, birds, mammals, amphibians and reptiles. "Riparian environments are also socio-economically important to Quebec hunters, fishers and trappers, bird watchers and nature lovers" (translation).[1] *To safeguard all these interests, it is* vital that we protect these habitats from degradation.

DEGRADATION OF THE SHORE

Riverbank degradation is an important issue. Only 449 km, or 29%, of the 1532 km of riverbanks inventoried is made up of stable natural bank. There are 399 km of eroding natural banks and 684 km of degraded banks or banks covered by erosion-protection structures such as curbs, riprap or *fill*.

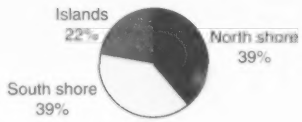
Causes

Encroachment for purposes of urban sprawl, industrial facilities or agriculture has led to the filling and draining of many riparian environments. Erosion is caused by both natural factors (tide, current, etc.) and by human activities like deforestation and shipping, among others.

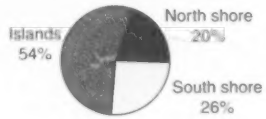
OVERVIEW OF RIVERBANKS: FLUVIAL SECTION AND ESTUARY

Riverbanks (1532 km)

Degraded banks (684 km – 45%)



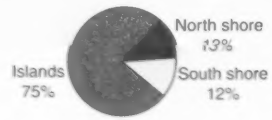
Natural banks (848 km – 55%)



Banks (km)		Degraded (km)	Natural (km)
North	433	264	169
South	489	269	220
Islands	610	151	459

ERODING RIVERBANKS

Of the 1532 km of shoreline inventoried, 424 km of banks are eroding. Degraded banks make up 6% of eroding banks; natural banks 94%. The 399 km of natural banks being eroded break down as follows:



In the *upstream portion of the Fluvial Section*, riverbank erosion is caused by wind-generated waves and variations in the water level. Erosion in the *downstream portion of the Fluvial Section* results mostly from ship-generated waves and primarily affects natural island shores, generally those situated close to the ship channel. Lastly, in the *Fluvial Estuary*, erosion is caused by a combination of factors, including wind-whipped waves, tides, currents and ice.

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Source: 1. Les Consultants en environnement Argus Inc. 1996. *Restauration naturelle des rives du Saint-Laurent entre Cornwall et l'île d'Orléans. Guide d'interventions.* Prepared for Environment Canada – Canadian Wildlife Service, Ministère des Transports, James Bay Energy Corporation and Ducks Unlimited Canada.

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March 1997

The St. Lawrence River – Priority Tributaries of St. Lawrence Vision 2000

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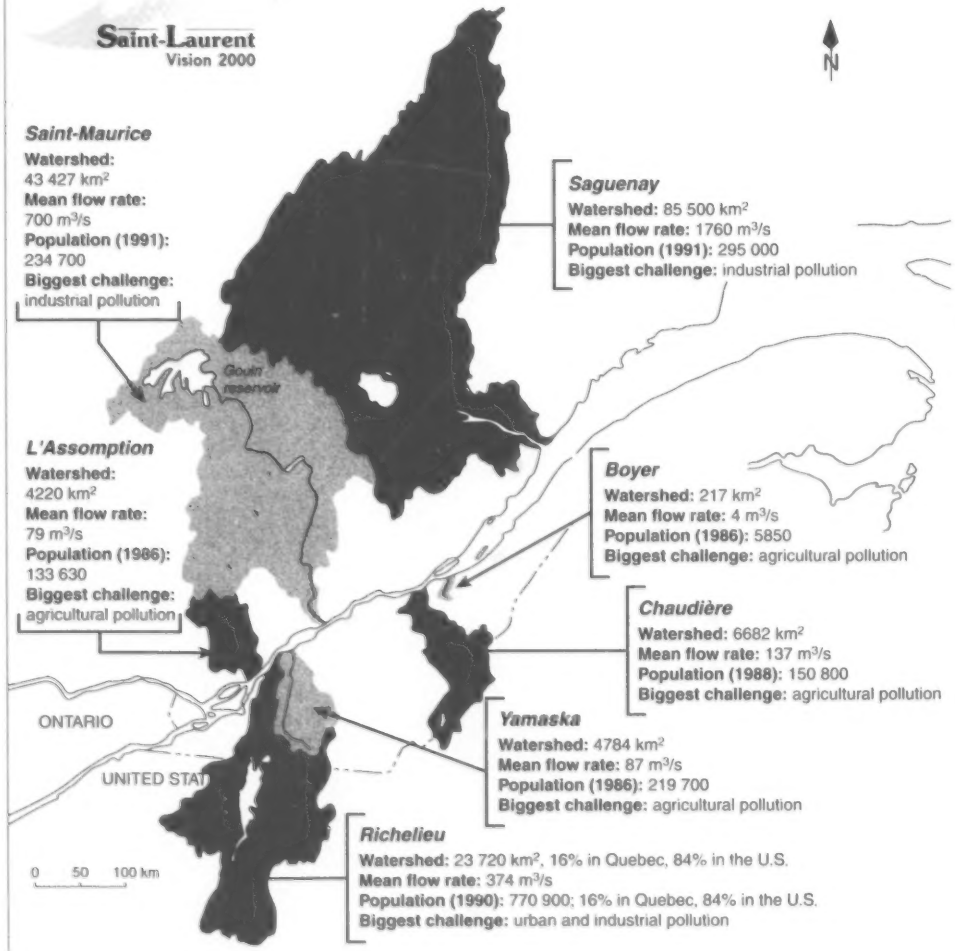

MAJOR INTERVENTION WORK, BY COMPONENT, UNDER ST. LAWRENCE VISION 2000	Boyer	Chaudière	L'Assomption	Richelieu	Saguenay	Saint-Maurice	Yamaska
AGRICULTURAL CLEANUP							
Preparation of an agri-environmental diagnostic report	X	X	X				X
Assessment of pesticide and fertilizer use	X	X	X				X
Assessment of pesticide contamination		X	X				X
Preparation of an action plan aimed at extending farm pollution cleanup work to the entire river basin	X	X	X				X
Farmers' pilot project to assess the effects of more environmentally-friendly farming practices			X				X
DECISION SUPPORT							
Monitoring the water's physico-chemical quality	X	X	X	X	X	X	X
Monitoring tributary health through the study of its fish and benthos	X	X	X	X	X	X	X
Monitoring water and fish contamination through the study of industrial-source toxics*		X		X	X	X	X
BIODIVERSITY							
Conservation and protection of threatened species and wildlife habitats	X	X	X	X	X	X	X
Restoration of spawning grounds (Rainbow smelt, Brook charr, Ouananiche, Walleye)	X				X		
Identification of plants likely to be designated threatened or vulnerable			X	X			
PROTECTION							
Monitoring the effluent quality at some SLV 2000 priority plants		X	X	X	X	X	X
COMMUNITY INVOLVEMENT							
Environmental intervention projects: riverbank cleanup, restoration, enhancement, etc.	X	X	X	X	X	X	X
Providing support to ZIP (Priority Intervention Zone) committees					X		

* Contamination monitoring under SLV 2000 may be limited to sampling operations. Such monitoring may also take place in other tributaries of the St. Lawrence.

LAND DIVISION (%), BY WATERSHED, 1986–1991

Tributary	Forest	Farming	Other*
Boyer	40	60	< 1
Chaudière	66	31	3
L'Assomption	68	21	11, including 6 in lakes and rivers
Richelieu (Quebec portion)	49	44	7
Saguenay	90	2	8, mostly in lakes and rivers
Saint-Maurice	85	< 1	15, including 10 in lakes and rivers
Yamaska	28	67	5

* Other: urban area, recreation area, lakes and rivers, wetlands, bare soil.

Source:
- Comité de bassin de la rivière Chaudière (COBARIC). 1996. *Vers une gestion intégrée et globale des eaux du Québec*. Final report.
- Hébert, S. 1995. *Qualité des eaux du Saguenay–Lac-Saint-Jean, 1979-1992*. Ministère de l'Environnement et de la Faune.
- Laflamme, D. 1995. *Qualité des eaux du bassin de la rivière Saint-Maurice, 1979 à 1992*. Ministère de l'Environnement et de la Faune.
- Le Groupe d'intervention pour la restauration de la Boyer, 1996. *La Boyer de long en large. Volume 1 : Recueil des connaissances actuelles*.
- Primeau, S., and Y. Grimard. 1990. *Rivière Yamaska, 1975-1988. Volume 1 : Description du bassin versant et qualité du milieu aquatique*. Ministère de l'Environnement et de la Faune.
- Simoneau, M. 1993. *Qualité des eaux du bassin de la rivière Richelieu, 1979 à 1992*. Ministère de l'Environnement et de la Faune.
- Simoneau, M., and Y. Grimard. 1989. *Qualité des eaux du bassin de la rivière L'Assomption, 1976-1987*. Ministère de l'Environnement et de la Faune.
- St. Lawrence Vision 2000. 1996. *Biennial Report 1993–1995*. Government of Canada and Government of Quebec.

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March 1997

The St. Lawrence River – Priority Intervention Zone: Lake Saint-Louis

Here, the River...

♦ forms its third-largest lake (148 km²) at the confluence of the Great Lakes and the Ottawa River; ♦ has a floodplain of 12 km²; ♦ with water-level fluctuations that go largely unnoticed because of upstream control structures; ♦ and where sediment deposition helps to create habitats for wildlife.

A Natural Beauty...

♦ rich in diversified habitats that serve as nesting, spawning and calving grounds (e.g. Îles de la Paix); ♦ home to a number of wildlife species: 78 fishes, over 300 birds, and more than 10 mammals; ♦ a major migratory staging ground for waterfowl, especially in fall; ♦ migratory routes for American eel, American shad, and Lake sturgeon; ♦ a number of bird colonies: Great blue heron, Ring-billed gull, and Black tern; ♦ with vulnerable and threatened species: 40 plants, 4 fishes, 10 birds, and 4 amphibian or reptile species.

The Human Presence

♦ The study area includes 20 riverside municipalities and one Native Indian reserve with 209 311 inhabitants in 1991; ♦ a major urban and industrial centre (Montreal) and several secondary centres (Beauharnois-Melocheville, Lachine and Île Perrot); ♦ an urbanized shoreline (68%) where agriculture and cottaging (29%) are concentrated on the south shore; ♦ 10 priority industrial plants (pulp and paper, metallurgy, surface treatment); ♦ many recreational and tourist attractions: historic, cultural or heritage sites, boating, swimming, hunting, sport fishing and waterfront parks.

A Big Part of Everyday Life, the St. Lawrence...

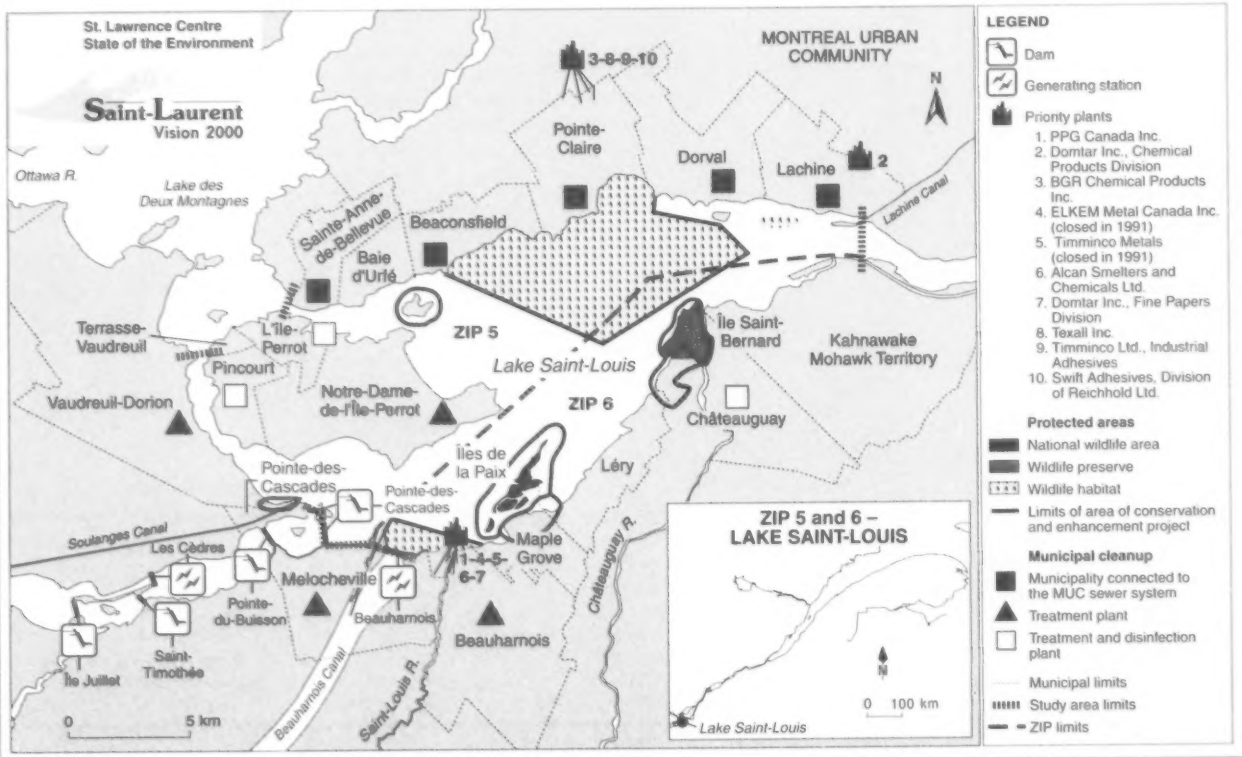
♦ provides drinking water: 10 filtration plants serve 91% of the population; ♦ is used for the discharge of municipal wastewater, including the treated wastewater of 95% of the riverside population; ♦ and commercial shipping: between 1983 and 1990, 40 million tonnes of cargo was transited through the St. Lawrence Seaway; ♦ and for the discharge of industrial effluents from plants situated outside MUC territory; ♦ for boating: 31 marinas and 81% of vessels in the Montreal archipelago; ♦ commercial fishing, with average annual landings of 55 t, 90% of which is Lake sturgeon, despite the steep drop in its numbers since the 1950s; ♦ waterfowl hunting: an average of 15 000 ducks taken between 1977 and 1981.

The Legacy of an Urban Lifestyle

♦ Bacterial contamination and chemical pollution of the water; ♦ sediments polluted by heavy metals (e.g. mercury) and organic compounds like PAHs and HCBs, particularly in the southern end of the lake; ♦ restricted fish consumption, due mainly to mercury levels; ♦ reduced accessibility and degradation of riverbanks (at least 60%), especially on the north shore; ♦ erosion of banks and aquatic plant communities by wave battering, especially north of the Îles de la Paix; ♦ the loss of 435 ha of fish habitats from 1945 to 1988.

The River can be Reclaimed by...

♦ industrial and municipal cleanup programs; ♦ increasing public awareness and sensitizing local representatives to the natural attractions of the lake and to wetland preservation; ♦ implementing a recreation and conservation network linked to the River (e.g. bicycle paths, nature interpretation centres, etc.); ♦ the protection of wildlife habitats (e.g. Îles de la Paix, Goyette and Hebert points, Saint-Jean creek, and Saint-Bernard Island).



Source:
- St. Lawrence Centre. 1996. Info-Flash 73 – "Contamination of Sediment in Lake Saint-Louis (1990)." Environment Canada – Quebec Region, Environmental Conservation.
- Gervais, D., and C. Lachance. 1996. *Plan d'action et de rehabilitation écologique du lac Saint-Louis*. Comité ZIP du Haut Saint-Laurent.
- Technical reports and regional assessment report on Lake Saint-Louis. 1994. Environment Canada – Quebec Region, Environmental Conservation, St. Lawrence Centre. Reports on Priority Intervention Zones 5 and 6.

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March 1997

The St. Lawrence River and the Priority Intervention Zone Program

THE GOVERNMENT PARTNERS of the St. Lawrence Vision 2000 action plan recognize the importance of riverside populations to the success of efforts aimed at protecting and conserving the river ecosystem. This is the spirit in which the Priority Intervention Zones Program (better known by its French acronym, ZIP) was born.

OBJECTIVES

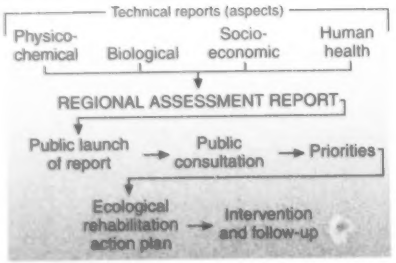
To stimulate and support public participation in defining local intervention priorities, and preparing and implementing ecological rehabilitation action plans (ERAPs).

ZIP PROGRAM PARTNERS

Under the Community Involvement component of St. Lawrence Vision 2000, the federal and provincial governments signed an Agreement of Cooperation in April 1995 with *Stratégies Saint-Laurent*. (SSL). This non-profit group has been responsible for coordinating St. Lawrence riverside populations, through the auspices of the various ZIP committees, since 1989.

SSL is largely made up of ZIP committees representing socio-economic and community groups, municipalities, industry, environmental groups and citizens. The ten ZIP committees that have been created since April 1, 1996 cover different sectors of the St. Lawrence, from Lake Saint-François all the way to Chaleur Bay (see map).

ZIP PROGRAM PHASES



THE PARTNERS' PRIMARY ROLE

Federal and Provincial Governments

To publish the synthesis report for each of the 13 study areas.

Strategies Saint-Laurent

To promote the ZIP program with riverside residents and to establish ZIP committees.

ZIP Committees

To facilitate exchanges with the public about which actions to prioritize, and to prepare and follow-up the ERAP.

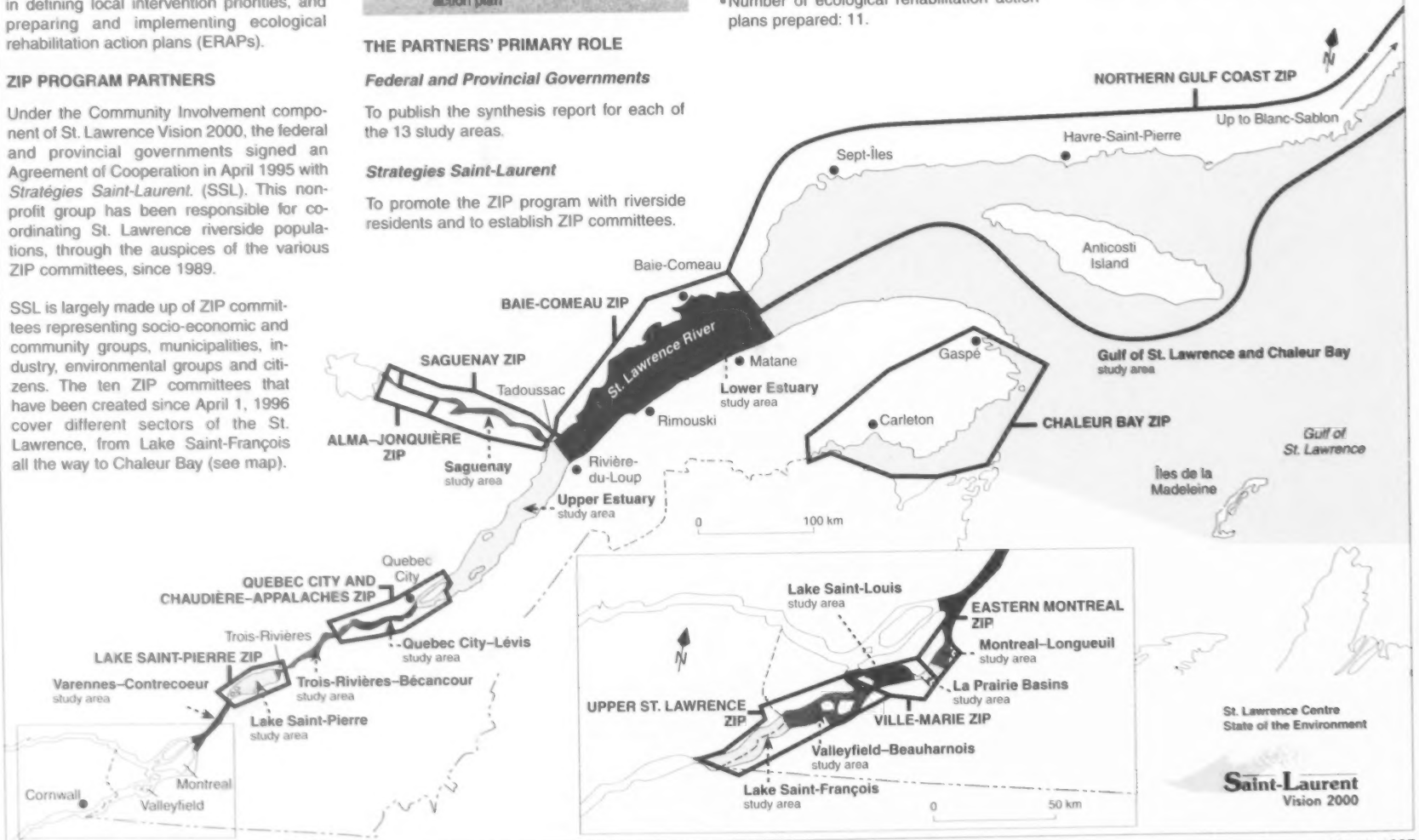
RESULTS EXPECTED BY END OF SLV 2000 (March 31, 1998)

- Number of regional assessment reports completed: 13.
- Public forums held: 11.
- Number of ecological rehabilitation action plans prepared: 11.

EXAMPLES OF PRIORITIES IDENTIFIED AT PUBLIC MEETINGS

Themes

- Education, public awareness, dialogue.
- Habitat protection and rehabilitation.
- Pollution control.
- Studies, research, surveys.
- Restoration of contaminated sites.
- Enhancement of natural resources.



March 1997

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The St. Lawrence River – Relative Importance of Lead in Sediment

LEAD enters into watersheds via the water cycle and by atmospheric deposition. It is distributed throughout the hemisphere and has even been found in ice in Greenland.

Lead is primarily carried into the environment as particles in the air. Once in surface waters, these particles bond to the organic and inorganic matter suspended in water, slowly making their way to the water bottom. An estimated 13 000 tonnes of lead has accumulated in the Laurentian Channel over some 90 years. The presence of lead in sediments pre-dating the so-called industrial age (±1950) appears to be primarily the result of the erosion of lead-rich rocks in the watershed.

The lead used by the leaded metals and paint industries, along with the disposal of spent lead-zinc batteries, make up the largest reserves of lead that could potentially enter the environment.

Filtering molluscs and some crustaceans that live in polluted areas can concentrate lead at such high levels that they are unfit for human consumption.

Above 23 mg/kg, the harmful impacts of lead include a loss in the number and the diversity of benthic species (bottom-dwelling organisms). Above 42 mg/kg, the level of contamination is high enough to cause a reduction in the number of individuals in a community and community impoverishment. In excess of 170 mg/kg, benthic organisms suffer major harm.

Lead accumulation in sediments in the St. Lawrence River peaked in the 1960s and 1970s. These values dropped steadily with the introduction of unleaded gasoline in the early 1970s. The depth at which we find maximum lead levels varies according to the rate of sediment deposition.

	± 1950 LEAD LEVELS (mg/kg)
Lake Saint-François	0.20
Lake Saint-Louis	0.15
Saguenay Fjord	0.17
Lower Estuary	0.16
Gulf	0.16

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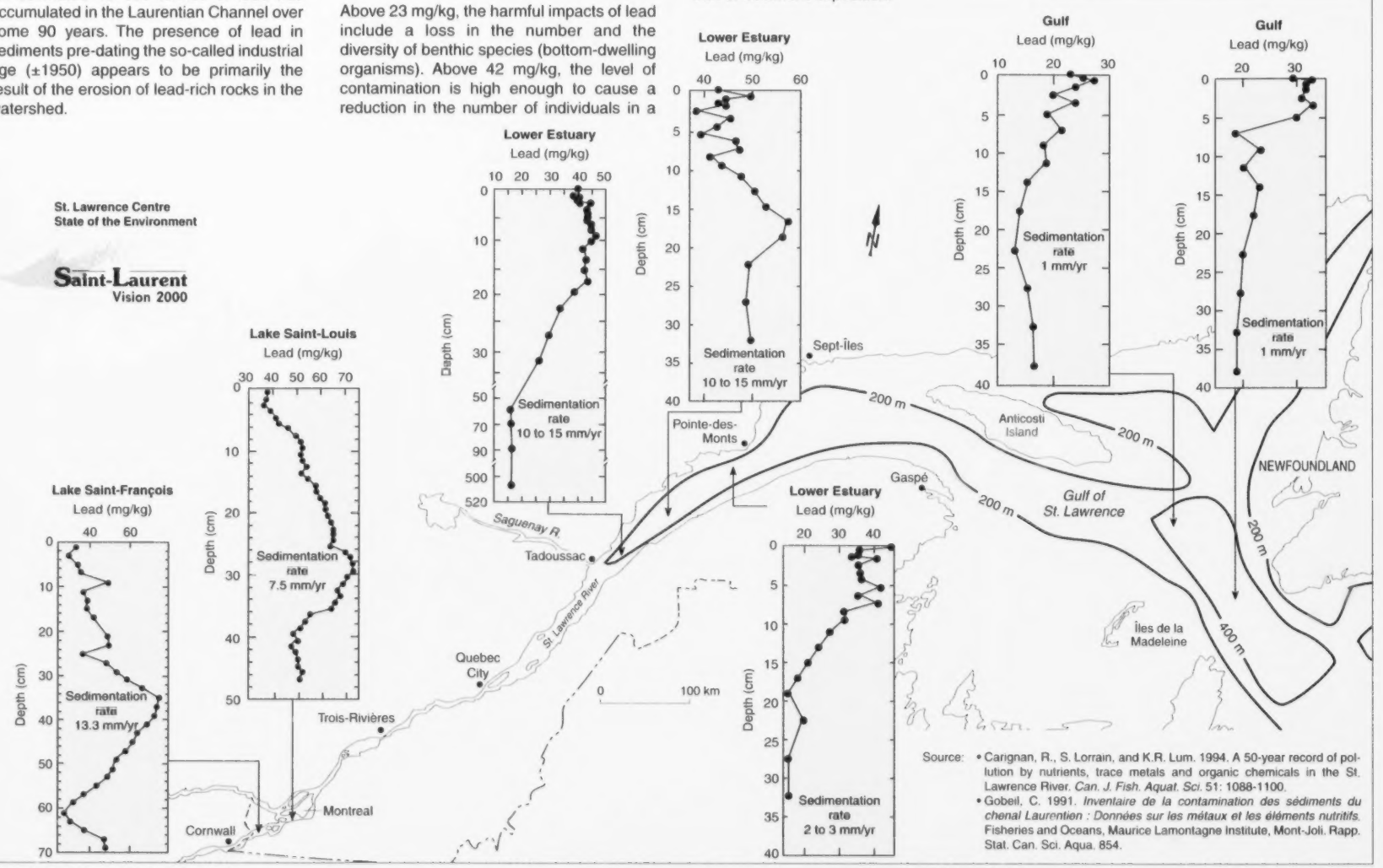

Source:
- Carignan, R., S. Lorrain, and K.R. Lum. 1994. A 50-year record of pollution by nutrients, trace metals and organic chemicals in the St. Lawrence River. *Can. J. Fish. Aquat. Sci.* 51: 1088-1100.
- Gobeil, C. 1991. *Inventaire de la contamination des sédiments du chenal Laurentien : Données sur les métaux et les éléments nutritifs.* Fisheries and Oceans, Maurice Lamontagne Institute, Mont-Joli. Rapp. Stat. Can. Sci. Aqua. 854.

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March 1997

The St. Lawrence River – Relative Importance of Cadmium in Sediment

CADMIUM is a rare element in nature. Some of the cadmium emitted to the air is carried along by air masses. Once released to a body of water, cadmium is easily integrated into the carbon cycle.

Cadmium has the capacity to bond strongly with the suspended matter in water. It is transferred to sediments via adsorption (process of adhesion to the surface of a solid substance, a gas, a liquid, or a dissolved substance) to organic and inorganic substances and by coprecipitation with iron, manganese and aluminum oxides. In the marine environment, the water's chemical and physical characteristics (pH, salinity levels) and the geology of the area greatly influence cadmium levels. Cadmium is used to manufacture a number of products (plastics, super-phosphated fertilizer, etc.).

Zinc and lead refineries alone are responsible for 82% of all cadmium discharges to the air and water.

A metal, cadmium is non-essential to life and may be toxic in very small amounts. Its residence time in living tissue is fairly long. Planktonic and benthic invertebrates appear to be especially sensitive, rapidly concentrating cadmium in their tissue.

Above 0.2 mg/kg, the harmful impacts of cadmium include a loss in the number and the diversity of benthic species (bottom-dwelling organisms). Above 3.0 mg/kg, the level of contamination is high enough to cause a reduction in the number of individuals in a community and community impoverishment. In excess of 170 mg/kg, benthic organisms suffer major harm.

Cadmium inputs to sediments in the St. Lawrence River peaked in the 1960s and 1970s. The depth at which we find maximum cadmium levels varies according to the rate of sediment deposition.

± 1950 CADMIUM LEVELS (mg/kg)	
Lake Saint-François	0.20
Lake Saint-Louis	0.15

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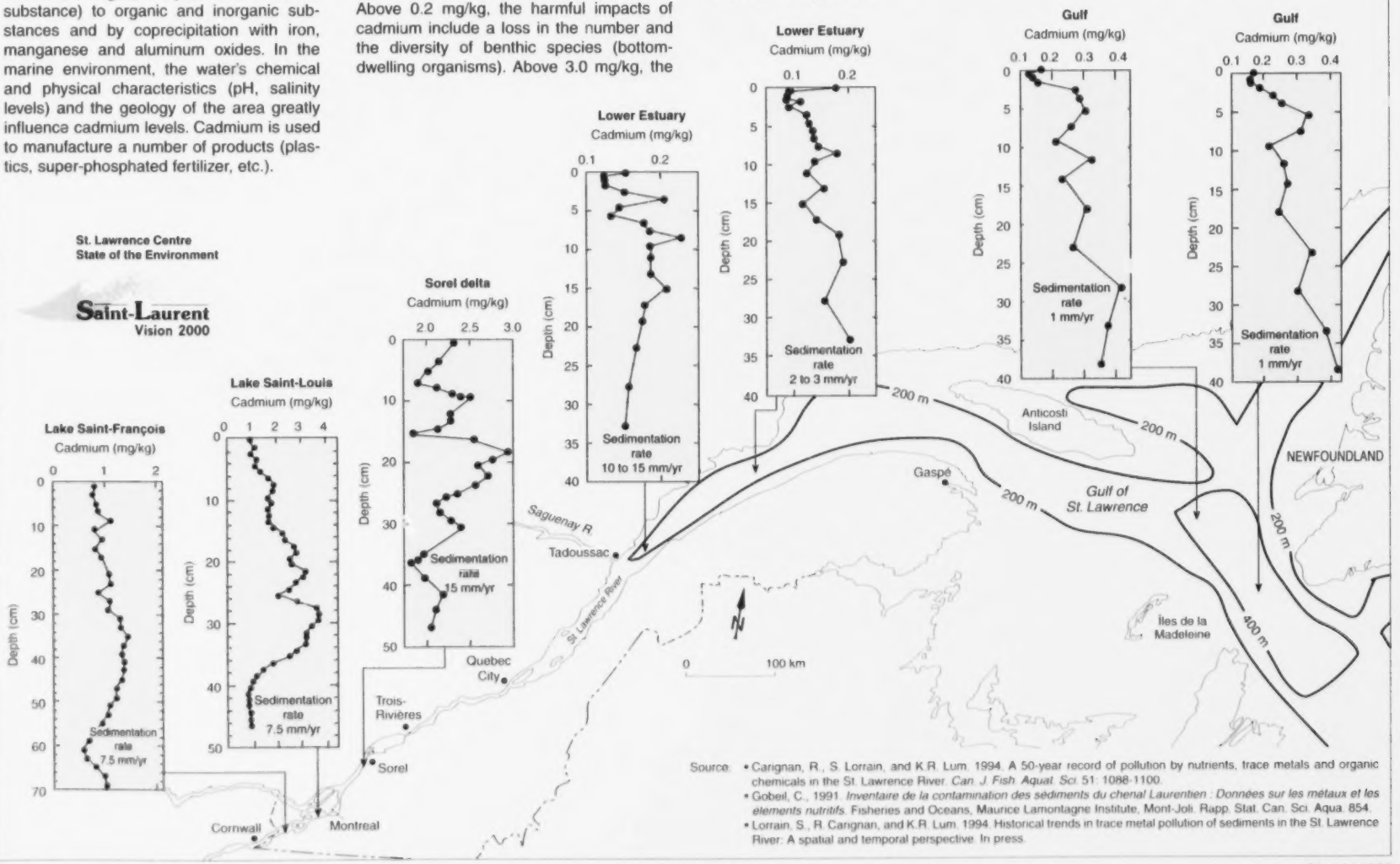
Saint-Laurent Vision 2000



Source:
- Carignan, R., S. Lorrain, and K.R. Lum. 1994. A 50-year record of pollution by nutrients, trace metals and organic chemicals in the St. Lawrence River. *Can. J. Fish. Aquat. Sci.* 51: 1088-1100.
- Gobeil, C., 1991. *Inventaire de la contamination des sédiments du chenal Laurentien : Données sur les métaux et les elements nutritifs.* Fisheries and Oceans, Maurice Lamontagne Institute, Mont-Joli. Rapp. Stat. Can. Sci. Aqua. 854.
- Lorrain, S., R. Carignan, and K.R. Lum. 1994. Historical trends in trace metal pollution of sediments in the St. Lawrence River: A spatial and temporal perspective. In press.

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March 1997

The Great Lakes–St. Lawrence River Basin – A Climatic Overview

The Great Lakes–St. Lawrence basin is roughly 1 609 000 km² in size, with 70% in Canada (Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland) and 30% belonging to the U.S. (Minnesota, Wisconsin, Illinois, Michigan, Indiana, Ohio, Pennsylvania, New York, and Vermont). In 1991, 42 650 000 people lived in this drainage basin; about 40% were Canadian, and 60% American. The population of the Great Lakes watershed numbered 33 200 000 people, while there were 9 450 000 living in the St. Lawrence drainage basin. The Great Lakes have a moderating effect on temperatures all along their shores, and also tend to increase precipitation (especially in winter, on wind-swept Great Lakes shores), intensify wind speed, and stir up fog.

St. Lawrence Centre
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Source:
- Government of Canada. 1996. *The State of Canada's Environment – 1996.*
- Government of Canada and U.S. Environmental Protection Agency. 1995. *The Great Lakes. Ecological Atlas and Resource Manual.* Third edition.
- Statistics Canada. 1994. *L'activité humaine et l'environnement – 1994.* Catalogue 11-509F.
- U.S. Census Bureau. 1996. Official Statistics. Internet site. (http://www.census.gov/).
- Vigeant, G. 1996. *Normales climatiques au Canada 1951 à 1990 et données climatiques des États-Unis.* Environment Canada, Atmospheric Environment Branch. Personal communication.

A
NORTH OF THE GREAT LAKES AND THE ST. LAWRENCE

Zone covered: Lake Superior; north of Lakes Huron and Michigan; north of the St. Lawrence up to Lake Saint-Jean.

Dominant land use: evergreen forest, mixed forest.

Continental climate: cool summers; long, cold, snowy winters.

	Mean annual precipitation (mm)	Mean annual temperature (°C)
ZONE A	700 to 1200	1.0 to 4.2
Thunder Bay	703	2.4
Sault Ste. Marie	906	4.2
North Bay	974	3.6
La Tuque	933	3.6
Chicoutimi	954	3.4

B
LOWLANDS OF THE GREAT LAKES AND ST. LAWRENCE

Zone covered: south of Lakes Huron and Michigan; Lakes Ontario and Erie; extreme southern tip of Quebec, lowlands from Montreal to Quebec City.

Dominant land use: farming, low population density urban areas.

Highly variable climate: warm summers, increased humidity west of Montreal; snowy and cold winters east of Lake Ontario and mild winters west of Lake Ontario.

	Mean annual precipitation (mm)	Mean annual temperature (°C)
ZONE B	700 to 1200	4.0 to 9.5
Chicago	805	9.4
Detroit	805	9.5
Buffalo	917	8.4
Rochester	795	8.8
Toronto	781	7.2
Kingston	964	6.7
Montreal	940	6.1
Quebec City	1208	4.0

C
NORTH OF THE ESTUARY AND GULF OF ST. LAWRENCE

Zone covered: north of the St. Lawrence and east of Lake Saint-Jean; north of the Gulf of St. Lawrence; western coast of Newfoundland; Cape Breton Island.

Dominant land use: evergreen forest.

Humid maritime climate and cold temperatures: cool, rainy summers; cold, and often snowy winters.

	Mean annual precipitation (mm)	Mean annual temperature (°C)
ZONE C	600 to 1600	1.0 to 5.2
Baie-Comeau	996	1.5
Sept-Îles	1128	0.9
Havre-Saint-Pierre	1046	1.6
Blanc-Sablon	1160	0.9
Corner Brook	1186	5.2

D
SOUTH OF THE LOWER ESTUARY AND GULF OF ST. LAWRENCE

Zone covered: Appalachian Mountains (south of the St. Lawrence in the Gaspé); uplands of New Brunswick and Nova Scotia; Prince Edward Island; Iles de la Madeleine.

Dominant land use: evergreen forest, mixed forest, farming.

Humid maritime climate and moderate temperatures: warm, rainy summers; mild to cold, and often snowy winters.

	Mean annual precipitation (mm)	Mean annual temperature (°C)
ZONE D	900 to 1600	3.5 to 6.0
Sherbrooke	1109	4.1
Rimouski	991	3.9
Gaspé	1044	3.2
Charlottetown	1201	5.2